REPORT RESUMES

ED 003 325 24

RELATIONSHIPS BETWEEN SELECTED LANGUAGE VARIABLES AND COMPREHENSION ABILITY AND DIFFICULTY.

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REPORT NUMBER CRP-2082 PUB DATE 64
EDRS PRICE MF-$0.27 HC-$5.76 144P.

DESCRIPTORS- *LINGUISTICS, STRUCTURAL ANALYSIS, *COMPOSITION (LITERARY), *READING COMPREHENSION, PREDICTION, TESTING, *PREDICTIVE VALIDITY, *INSTRUCTIONAL MATERIALS, MATERIAL DEVELOPMENT, STANDARDIZED TESTS, *CLOZE PROCEDURE, LOS ANGELES, CALIFORNIA,

A STUDY WHICH DEALT WITH ONE ASPECT OF THE QUESTION OF WHY ONE LANGUAGE IS EASY TO COMPREHEND WHILE ANOTHER IS NOT WAS REPORTED. SPECIFICALLY, IT STUDIED THE PROBLEM OF INCREASING THE PRECISION OF READABILITY PREDICTION. THE OBJECTIVES WERE (1) TO DETERMINE THE FORMS AND STRENGTHS OF THE RELATIONSHIPS BETWEEN COMPREHENSION DIFFICULTY OF LANGUAGE AND MEASURABLE DIMENSIONS (LINGUISTIC VARIABLES) OF THAT LANGUAGE, (2) TO TRY OUT NEW LINGUISTIC VARIABLES USEFUL PREDICTORS OF COMPREHENSION DIFFICULTY, AND (3) TO FIND OUT IF USEFUL PREDICTIONS CAN BE MADE OF THE READABILITIES OF SMALLER LANGUAGE UNITS. CLOZE TESTS AND A STANDARDIZED TEST OF READING ACHIEVEMENT WERE APPLIED TO APPROXIMATELY 900 PUBLIC SCHOOL STUDENTS IN GRADES 4 THROUGH 8. TESTING PRODUCED COMPARABLE DIFFICULTY VALUES FOR EACH WORD IN 20 PASSAGES. A CORRELATION ANALYSIS OF OVER 30 COMBINATIONS OF LINGUISTIC VARIABLES FOR EACH 300-WORD PASSAGE REVEALED THE COMPARATIVE VALIDITY OF VARIOUS READABILITY PREDICTION METHODS. (JM)

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RELATIONSHIPS BETWEEN SELECTED LANGUAGE VARIABLES AND COMPREHENSION ABILITY AND DIFFICULTY

Cooperative Research Project
Number 2082

JOHN R. BORMUTH

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LOS ANGELES

1964

The research reported herein was supported by the Cooperative Research Program of the Office of Education, U.S. Department of Health, Education, and Welfare.

ED 003325

Foreword

I want to take this opportunity to formally thank all of those who have helped me in the conduct of this study. To do so properly would require me to start by listing all of those scholars upon whose work I have drawn. If I could do so, Wilson, Taylor, Gray, Dale, Lorge, and Klare would certainly be among them. But special mention should be made of Dr. Jeanne Chall whose monograph, Readability: An Appraisal of Research and Application did much to organize my thinking in this area and to direct my attention to the problems that I have chosen to study.

Nor can the assistance of the U.S. Office of Education be overestimated. Without its support, this undertaking would have been impossible, and without its advice, this study would have omitted the part of speech ratio which yielded such surprising results.

The students and staff of the Wasco Union Elementary Schools also deserve special thanks; the children for their time and industry in taking some 23 tests; the faculty for giving up instructional time and for extending friendly hospitality to the researcher and his assistant; the principals, Harold Buntain, Ingwer Ketelsen, and Edward Petersen whose administrative assistance they generously gave; the Board of Education and Superintendent John Preueitt, for permission to perform the experiment in their schools; and assistant superintendent James Foster whose outstanding administrative planning and continuous help insured the smooth operation of the testing phase of the study.

My warmest thanks go to those who worked with me directly in turning my ideas and conjectures into evidence bearing operations. Mrs. Ora Hook's intelligent and meticulous attention to detail was of vital importance in maintaining rigorously controlled conditions during the testing. Mrs Angela Borelli and Mr. Gene Bunkowski, who performed the linguistic analysis, contributed invaluable services. Ruth Epstein and Virginia Castleton, who have worked on this project from the first pilot studies through its completion, have been of invaluable assistance in performing and supervising the test scoring and analyses. Further, thanks are due to Margaret Buck, Geraldine Donahue, and Merrilee Mummery whose painstaking labors in scoring the tests, tabulating data, typing, and performing the calculations transformed the masses of raw data into a manageable form. Finally, a large debt of gratitude is owed Mr. Steven Crocker who performed all of the computer programming and computer processing for this project. The handling of the vast quantities of data involved in this study could not have been accomplished without his help and advice.

TABLE OF CONTENTS

Chapter Page

I. PROBLEM

A. Introduction 1
  Problem 1
  Importance 1
B. Problems Investigated 3
  Forms of the Relationships 3
  New Linguistic Variables 4
  Readability Prediction on Small Language Units . . 4
C. Linguistic Variables. 4
  New Variables 4
  Established Variables 8
D. Problems of Research Technology 10
  Measurement of Comprehension Difficulty 10
  Quantification of Linguistic Variables. 12
E. Improvements in Research Techniques. 13
  Cloze Tests. 13
  Contributions from Psycholinguistics 14

II. OBJECTIVES

A. Form and Strength of the Relationships. 16
  Linearity of Regression. 16
  Variable Strength as a Function of Levels of Reading Achievement 16
  Analyses Performed on All Variables. 17
B. Special Analyses of New Variables 17
  Net Measures 17
  Words in Prepositional Phrases 17
  Independent Clause as the Unit of Syntactic Analysis 18
  Number of Letters. 18
  Part of Speech Ratios 19

Chapter Page

C. Prediction of the Readability of Smaller Language Units 19

III. REVIEW OF RELATED RESEARCH

A. Validity of Cloze Test. 20

Dual Aspects of Cloze Test Validity 20
Validity as Measures of Comprehension Ability . . 20
Validity as Measures of Comprehension Difficulty . 21

B. Forms of the Relationships 21

Linearity of the Correlations 21
Variable Strength as a Function of Levels of Achievement. 22

C. Linguistic Variables 23

New Variables. 23
Established Variables 25

D. Readability Prediction at Lower Levels of Analysis. 27

IV. PROCEDURE

A. Measurement of Comprehension Difficulty 28

Subjects 28
Cloze Test. 29
Testing Procedure 31

B. Criterion Variable 32

Computation of Comprehension Difficulty 32

C. Linguistic Variables 34

Levels of Analysis 34
Part of Speech Variables 45

V. ANALYSES AND FINDINGS

A. Linearity of the Relationships 47

Method of Analysis 47
Limitations of the F Test. 47

Chapter Page

Interpretation of Negative F Values 48
Word Level of Analysis 49
Independent Clause Level of Analysis 50
Sentence Level of Analysis 54
Passage Level of Analysis. 54

B. Variable Strength as a Function of Levels of Reading Achievement 59

Purpose. 59
Method of Analysis 59
Word Level. 61
Independent Clause Level 64
Sentence Level 64
Passage Level. 70

C. New Variables. 79

Contrasts of Similar Variables 79
Net and Total Measures. 80
Prepositional Phrases and Words in Prepositional Phrases 80
Independent Clause and the Sentence 81
Comparisons of Letters with Syllables and Words as Measures of Length 83
Part of Speech and Form Class Ratios 85
Form Class Ratios 85
Part of Speech Ratios 86

D. Other New Variables. 88

Word Depth. 88
Independent Clause Frequency. 88
Letter Redundancy 88

E. Readability Prediction at Lower Levels of Analysis. 89

Purpose. 89
Method of Analysis 89
Limitations of the Method of Analysis. 90
Word Level. 90
Independent Clause Level 92
Sentence Level 95
Passage Level. 95
Traditional and Form Class Variables 95
Part of Speech Variables 102
Comparisons Among the Levels of Analysis. . . . 107

Chapter Page

VI. CONCLUSIONS AND IMPLICATIONS

A. Linearity of the Relationships 108
Word Level of Analysis 108
Independent Clause Level of Analysis 109
Passage Level of Analysis 110

B. Variable Strength as a Function of Reading Achievement 110
Purpose 110
Word Level 110
Independent Clause Level 111
Passage Level 112

C. New Variables 113
Contrasts of Similar Variables 113
Net and Total Measures 113
Prepositional Phrases and Words in Prepositional Phrases 113
The Independent Clause and the Sentence 114
Letters Compared with Syllables and Words as Measures of Length. 114
Part of Speech and Form Class Ratios 114
Other New Variables 115
Word Depth 115
Independent Clause Frequency 115
Letter Reduncancy. 115

D. Readability Prediction at the Lower Levels of Analysis 116
Predictions at Lower Levels of Analysis 116
A New Readability Formula 118

BIBLIOGRAPHY 119

APPENDIX. 123
Appendix A: Bibliographical Data of Experimental Passages. 123
Appendix B: Typing Instructions. 129
Appendix C: Instructions 131

LIST OF FIGURES

Figure Page

1. Illustrations of Word Depth Analysis of Sentences. . . 38

2. Plots Showing the Mean Linguistic Variable Values of the Language Units Falling in Successive Intervals of Comprehension Difficulty, Calculated for Variables Derived at the Word Level of Analysis 51

3. Plot Showing the Mean of the Linguistic Variable Values of the Passages Falling in Successive Intervals of Comprehension Difficulty, Calculated for the Relationship between the Proportion of Words on the Dale List of 3000 Familiar Words and Comprehension Difficulty 53

4. Variations of the Mean Difficulties of the Words in the Upper and Lower Thirds on Each Linguistic Variable about the Mean Difficulty of the Words in the Middle Third Expressed in Difficulty Units . . 63

5. Variations of the Mean Difficulties of the Independent Clauses in the Upper and Lower Thirds on Each Linguistic Variable about the Mean Difficulty of the Independent Clauses in the Middle Third Expressed in Difficulty Units 68

6. Variations of the Mean Difficulties of the Passages in the Upper and Lower Thirds on Each Linguistic Variable about the Mean Difficulty of the Sentences in the Middle Third Expressed in Difficulty Units 75

LIST OF TABLES

Table Page

1. Analysis of Variances of the Reading Achievement Scores of the Form and Achievement Groups 34

2. Definitions of the Linguistic Variables Derived from the Basic Counts and Calculated for the Language Units at Each Level of Analysis 35

3. The Part of Speech Sub-Classes, the Traditional Part of Speech Categories, and the Form Classes Used in Classifying Words in the Passages. 46

4. Pearson Product Moment and Eta Correlations of Word Difficulty with Each of the Linguistic Variables and the F Ratios Obtained from the Tests of Linearity . . 49

5. Pearson Product Moment and Eta Correlations of Independent Clause Difficulty with Each of the Linguistic Variables, and the F Ratios Obtained from the Tests of Linearity. 52

6. Pearson Product Moment and Eta Correlations of Passage Difficulty with Each of the Linguistic Variables, Including the Ratios Obtained from the Classes, and the F Ratios Obtained from the Tests of Linearity . . 55

7. Analysis of Variance and Multiple Range Test of the Word Difficulties of Words in the High, Middle, and Low Thirds on Each Linguistic Variable 62

8. Analysis of Variance and Multiple Range Test of the Independent Clause Difficulties of Independent Clauses in the High, Middle, and Low Thirds on Each Linguistic Variable. 65

9. Distributions of Sentence and Independent Clause Difficulties. 70

10. Analysis of Variance and Multiple Range Test of the Passage Difficulties of Passages in the High, Middle, and Low Thirds on Each of the Linguistic Variables . . 71

11. Comparisons of the Sizes of the Correlations with Comprehension Difficulty that were Obtained from the Net and Total Measures of Word Depth and Number of Syllables in Independent Clauses and Sentences . . 80

Table Page

12. Comparisons of the Sizes of the Correlations with Comprehension Difficulty that Were Obtained from the Number of Prepositional Phrases and Words in Prepositional Phrases at the Passage Level of Analysis 81

13. Comparison of the Sizes of the Correlations with Comprehension Difficulty that Were Obtained from the Variables Based on the Sentence and on the Independent Clause as the Unit of Syntactic Analysis at the Passage Level 82

14. Comparisons of the Sizes of the Correlations with Comprehension Difficulty that Were Obtained from the Variable Based on the Letter and the Other Two Measures of Unit Length, the Syllable and the Word . . 84

15. Correlations between Passage Difficulty and Each of the Form Class Ratios. 86

16. Correlations between Passage Difficulty and Each of the Part of Speech Ratios 87

17. Correlations among the Variables Derived at the Word Level of Analysis 90

18. Linear Multiple Regression Analysis of the Correlations between Word Difficulty and the Linguistic Variables Derived at the Word Level of Analysis 91

19. Intercorrelations among Independent Clause Difficulty and the Linguistic Variables Derived at the Independent Clause Level of Analysis. 93

20. Linear Multiple Regression Analysis of the Correlations between Independent Clause Difficulty and the Linguistic Variables Derived at the Independent Clause Level of Analysis 94

21. Intercorrelations among Sentence Difficulty and the Linguistic Variables Derived at the Sentence Level of Analysis 96

22. Linear Multiple Regression Analysis of the Correlations between Sentence Difficulty and Linguistic Variables Derived at the Sentence Level of Analysis 97

Table Page

23. Intercorrelations among Passage Difficulty and the Form Class and Traditional Type Variables 98

24. Linear Multiple Regression Analysis of the Correlations between Passage Difficulty and Linguistic Variables Derived at the Passage Level of Analysis Including the Form Class Ratios but Excluding the Part of Speech Ratios. 100

25. Intercorrelations Among Passage Difficulty and Each of the Part of Speech Ratios 103

26. Linear Multiple Regression Analysis of the Correlations between Passage Difficulty and the Part of Speech Ratios Derived at the Passage Level of Analysis . . . 105

CHAPTER I

PROBLEM

Introduction

Problem

This study dealt with one aspect of the question of why some language is easy to comprehend while some is not. Specifically, it studied the problems of increasing the precision of readability prediction. The objectives were (a) to determine the forms and strengths of the relationships between the comprehension difficulty of language and measurable dimensions (linguistic variables) of that language, (b) to try out new linguistic variables to see if they are useful predictors of comprehension difficulty, and (c) to find out if useful predictions can be made of the readabilities of smaller language units.

Importance

Necessity of Precise Readability Prediction. The practical realities of transmitting information to children cause educators to view this as a problem of major importance. They must select materials that are neither so easy that they offer no challenge to the children, nor so difficult that the children bog down. Failure to select materials that are appropriate can lead either to boredom or to frustration but seldom to optimum learning.

Inadequacy of Present Prediction Methods. It is problematical whether present knowledge helps or hinders educators in judging the difficulty of materials. The most accurate procedure is to try the materials out on the children for whom they are intended, but this requires special skills of teachers and is time consuming and expensive. In place of this, readability formulas are widely and often exclusively used by schools because they require little expense. Chall (1958) has strongly advised against this practice, pointing out that the validities of the formulas are in the range of .5 to .7, that their standard errors are at least one year of grade placement, and that even this estimate is uncertain because of the varied and often dubious criteria against which the formulas were validated. Nevertheless, the formulas continue to enjoy wide usage by the schools.

Effects on Instructional Materials. Publishers, being well aware of the habits of their customers, are forced to adjust their materials to make them conform to specifications derived from the readability formulas. This is done by substituting words from some list of easy words and by shortening sentences.

These adjustments have two unfortunate consequences. First, studies such as those by Nolte (1937), Robinson (1940), and Young (1950) show that such adjustments have little or no effect on altering the actual difficulties of the passages. Consequently, if materials are too difficult to begin with, they probably remain so, even though the "easier" words and shorter sentences make them appear otherwise to the educators who rely on the formulas.

Second, since publishers, for competitive reasons, must insist that their authors use rigidly limited vocabularies and short sentences, insipid and absurd writing often results. Prominent authorities such as Strickland (1962) have voiced serious concern about the possible harmful effects of these materials upon the interests and aesthetic learnings of children.

Problems Investigated

Forms of the Relationships

Linearity. Precise prediction of readability depends on more than just a knowledge of the sizes of the correlations between linguistic variables and comprehension difficulty. Knowledge of whether or not the relationships are linear is required. And, if they are curvilinear, a knowledge of the shape of the curve is required. Present prediction methods uniformly assume that all relationships are linear. This study questioned whether the relationships were indeed linear and offered preliminary information about the shapes of the curves.

Change in Variable Strength as a Function of Levels of Reading Achievement. The notion that a variable is equally effective in predicting readability for subjects at all levels of reading achievement was tested. Precise prediction requires a knowledge of this fact. The literature on readability contains many statements to the effect that special readability formulas must be developed for groups that differ in achievement. The small amount of evidence offered in support of these statements, however, is rather indirect. This study provided a test of these statements.

Relevance of these Findings. Positive findings with respect to these tests may be interpreted as meaning that the traditional practice of using readability formulas based on linear multiple correlation equations may have to be discontinued or that the values obtained from language variables must first be transformed before they are used in these equations. Positive findings could also mean that different formulas must be used for subjects having different levels of achievement in reading.

New Linguistic Variables

Greater precision of readability prediction can also be attained by discovering linguistic variables that yield higher correlations with comprehension difficulty than those currently in use. Several new variables were tried out in this study. Some represented new ways to use well known counting methods. In the next section of this chapter these variables will be discussed in some detail.

Readability Prediction on Small Language Units

The third general problem taken up in this study was to find the smallest language unit for which useful readability predictions could be made. Instructional materials which, on the whole, may be of suitable difficulty often contain words or clauses which appear to be extraordinarily difficult. At present there is no way to ascertain if they are as difficult as they seem.

Linguistic Variables

New Variables

None of the four variables discussed in the following section has been tested in a major study of readability prediction. As a consequence, their development and rationales are discussed in some detail. But, their detailed definition has been reserved to Chapter IV.

Word Depth. The word depth measure of sentence complexity was originally developed by Yngve (1960) for use in a type of computer translation of languages where the computer had to be able to construct grammatically correct sentences. In order to do this the computer had to store, temporarily, certain facts about the syntax of the sentence as it is constructing it. Word depth analysis was developed in order to find out how many grammatical facts a computer would have to be temporarily storing at any given time as it produced any given sentence. Yngve suggested that the difficulty people experience in comprehending complex sentences may be a result of the large number of grammatical relationships of which they must keep track. He offered the word depth analysis as a possible measure of the complexity of the syntax of a sentence.

Letter Redundancy. The redundancy measure is an application of Shannon's (1948) mathematical information theory. Its rationale, as it is relevant to this study, might be stated in this manner. Language is a sequentially patterned behavior. That is, sounds, letters, words, and other language units do not occur in all possible sequential orders. Rather, the occurrance of one element restricts the range of elements that will follow it. Through experience, people learn these patterns. As a result, knowledge of one element in a message gives them some knowledge of what the subsequent elements will be. Patterning, then, induces redundancy into a message. Presumably, messages differ in redundancy, and it would be reasonable to expect the comprehension difficulties of messages to vary inversely with their redundancies. The mathematical method of calculating redundancy that was used in this study was derived by Newman and Waugh (1960), adapted, and programmed for use with computers by Carterette and Jones (1963). Within each of the passages studied, it provided a measure of the degree of redundancy of the letter sequences in the text.

Independent Clause Frequency. The rationale of this variable states that people most easily comprehend the grammatical patterns that they hear most frequently and have greater difficulty comprehending patterns that they seldom hear. Strickland (1962) devised a method of identifying different independent clause patterns and tabulated the frequency with which each of these patterns occurred in the oral language of elementary school children. The pattern of each independent clause found in the passages that were included in this study was similarly analyzed, assigned the frequency number associated with that pattern in Strickland's tabulations, and this number correlated with comprehension difficulty.

Net Measures. The counting operations by which numbers of syllables and total word depths of independent clauses and sentences are found suggest an alternative method of performing them. The method is to subtract the number of words from the total word depth or the total number of syllables in the independent clause or sentence. It can be conjectured that the difficulty of an independent clause or sentence is due to the difficulties of the words in it rather than to the number of words that it contains. To subtract the effects due to the number of words in each is, in this reasoning, to subtract irrelevant variance; hence, an increase in correlation should result. Net numbers of syllables, and net word depths were among the variables studied.

Words in Prepositional Phrases. It was speculated that counts of the number of prepositional phrases in passages might correlate with comprehension difficulty merely because they furnish a measure of sentence length. If this is so, variables based on counts of the numbers of words appearing in prepositional phrases should have even higher correlations.

The Independent Clause as a Unit of Analysis. The sentence, that is the words falling between an initial capital letter and a terminal punctuation mark, has been commonly used as the unit upon which measures of sentence complexity are based. This practice ignores the compound sentence which is really two or more separate sentences joined by a coordinating conjunction. Insisting that the presence of a coordinating conjunction makes them into a single semantic or syntactic unit seems tantamount to denying that any semantic or syntactic relationships exist where a coordinating conjunction is absent. In any case, the independent clause was used as a unit of analysis and the results compared with those obtained from the sentence as a unit of analysis.

Number of Letters. A count of the number of letters in a word, independent clause, or sentence, can be used as a measure of the lengths of these language units. The rationale of obtaining a measure of word length can be based upon Zipf's (1935) findings that the length of a word correlates inversely with its frequency. Since the probability of a person understanding a word is probably directly related to the frequency with which he has encountered the word, it seemed likely that this variable would correlate with comprehension difficulty. The rationale with respect to measuring the lengths of sentences and independent clauses states that long grammatical structures are likely to be more complex and, therefore, harder to comprehend.

Part of Speech Ratios. Since Boder (1940) published his studies of the ratios of adjectives to verbs in various samples of written language, it has been known that this ratio varies among authors and among writings in different subject matter areas. None of the other part of speech ratios have been studied. Even though they lacked the elegant rationale of the adjective to verb ratio all of the possible ratios were studied. But, since there are many subclasses within each part of speech category and an almost infinite number of ways to combine them, this study restricted itself to the eight parts of speech of traditional grammar and five of the form classes of modern linguistics.

Established Variables

The variables discussed in this section have been investigated in other readability studies, and most appear in at least one well known readability formula. Their rationales are well known and will be only briefly mentioned here. Exact definitions of these variables are given in Chapter IV.

Word Frequency Index. The frequency index of a word is found by referring to the "general count" in the Teacher's Word Book of 3000 Words by Thorndike and Lorge (1944). Lists in this book show the relative frequencies with which words were found to occur in samples of printed English. The rationale of this variable states that the probability of a person understanding a word is directly related to the frequency with which he has probably heard the word.

Number of Syllables. A count of the number of syllables in a word, independent clause, or sentence can be used as a measure of the lengths of these units. The rationale of using this is in many respects similar to that given for the use of a letter count. Flesch (1949) believes that a syllable count measures the abstractness of the concepts discussed in the passage, but his argument seems to ignore words like proof, truth, and ego.

Number of Words. A count of the number of words in an independent clause or sentence can be used as a measure of its length. The rationale of this practice is similar to the one given for measuring length in units of letters and syllables, except that no statement is made regarding the measurement of abstractness.

Words on the Dale List of 769 Words. The "Dale List of 769 Words" was compiled by Dale (1931) from those words common to the "International Kindergarten Union List" and to Thorndike's 1,000 most frequent words. The rationale of this variable is built on the rationale for word frequency and further states that an independent clause, sentence, or passage containing a high proportion of words which are found on this list will be easier to comprehend than a similar language unit containing a smaller proportion of these words.

Words on the Dale List of 3000 Familiar Words. This list was formed by Dale and presented in Dale and Chall (1948). The words on it are those which Dale found were known to 80 per cent of the children in grade 4. The use of this list is rationalized in the same way as is the use of the "Dale List of 769 Words."

Prepositional Phrases. This variable can be used in either of two ways. The number of prepositional phrases may be found or the numbers and proportions of words within prepositional phrases may be found. Lorge (1949) stated it as being his belief that a count of prepositional phrases yields a measure both of the complexity of syntax and of the density of ideas.

Problems of Research Technology

Many of the reasons for the relatively primative state of knowledge in this area can be traced to the techniques that researchers have been forced to use. These studies have been hobbled by two problems. First, there has been no satisfactory way to measure the comprehension difficulty of language. Second, it has been difficult to quantify many of the attributes of language that are thought to contribute to comprehension difficulty.

Measurement of Comprehension Difficulty

Comprehension Tests. Researchers have used many devices for determining the relative comprehension difficulties of passages, ranging from obtaining the subjective judgements of subjects and experts to the use of subjects' responses on carefully constructed comprehension tests over the passages. Even though the latter are commonly agreed to be the best, they have several serious shortcomings that make their use both difficult and of questionable validity.

The use of comprehension tests has been questioned on two accounts. First, they yield only one measure of the difficulty of a passage. This provides no way for the researcher to find out the difficulty of each of the words, sentences, or other language units smaller than the passage itself. Instead, he must be content to deal with the difficulty of the average of these smaller units. Therefore, any statement that he may want to make about the difficulties of the particular language units within a passage must necessarily be based on second or third order inferences. While this procedure probably gives a fair estimate of the overall relationship, it can tell the researcher little or nothing about where his prediction models were best or poorest. Further, it cannot be used to find out whether or not the relationship is linear.

Second, the very process by which comprehension tests are made almost inevitably insures that an estimate of passage difficulty will contain a large amount of error. Lorge (1939) pointed out that the difficulty of a test item can be altered greatly just by the way it is written. This makes it impossible to know how much of a test's difficulty is due to variations in a test writer's style and how much is due to the difficulty of the passage itself. Further, he pointed out that a child's score on these tests is also dependent upon his ability to read and comprehend the items. Bormuth (1962) suggested that other sources of irrelevant or error variance were (a) the accuracy of the test writer's own comprehension of the passage, and (b) his ability to phrase his intent precisely in writing the items.

Finally, the tests are extremely difficult to make. This single fact may have done as much to discourage research in this area as any other single factor.

Quantification of Linguistic Variables

Word Level of Language Analysis. Researchers commonly identify two levels of language analysis; the word level, and the syntactic or sentence level. The first, the word level, has been extensively studied by researchers such as Thorndike (1921), Lorge (1938), and Dale and Eichholz (1960). The methods that they have devised for predicting the difficulties of words are highly developed and will probably admit to only minor improvements in the future.

Syntactical Level. On the other hand, much less satisfactory results have been achieved from the attempts to measure and predict from the complexity of sentence syntax. The principal problem that researchers encountered in attempting to quantify syntactical complexity has been the absence of an objective way of analyzing syntactical relationships. As a result it has been impossible to develop rigorous models of how people respond to syntax. Without such models it has been impossible to develop counting operations that yield objective measures of the complexity of syntax.

Lorge (1939) and Dale and Chall (1948) have each found that the measure which best predicts comprehension difficulty is the mean number of words in the sentences of a passage. However, their findings also show that once a measure of vocabulary difficulty has been taken into account, measures based on the numbers of words in a sentence add only trivial amounts to the multiple correlation predictions of comprehension difficulty.

Improvements in Research Techniques

Advances in two areas have been incorporated into the design of the present study; cloze tests for the measurement of comprehension difficulty, and hypotheses developed in the area of psycholinguistics. These two elements were combined in this study for the first time, thus making possible a more precise study of the problem of predicting comprehension difficulty.

Cloze Tests

Construction. Cloze tests are made by deleting every fifth word from a passage and replacing each deleted word with an underlined blank space of a standard length. Subjects, who have not previously read the passages from which the tests are made, are given the tests and instructed to figure out what word was taken from each space and to write it in. Responses are scored correct when they exactly match the deleted words.

Difficulties of Individual Language Units. The difficulty of each language unit was calculated. This was done by making five different cloze test forms from each passage. In the different forms the deletion process was begun with successive words in the passage so that every word in the passage was deleted in one of the forms. By giving each of the forms to different groups who were similar in reading achievement, and by calculating the proportions of subjects responding correctly on each item, the difficulties of the words were obtained. Difficulties of language units larger than a word were obtained by averaging the difficulties of the words within the language unit.

Comparison of Cloze and Comprehension Tests. It should be noted that cloze tests are superior to comprehension tests in two respects. First, since they are made from the passages themselves, the readabilities of test items are not a matter of concern in their use. Second, since the tests are made by a simple, objective procedure, the item difficulties and validities are not confounded with the skill of the test maker.

Advantages in Data Analysis. With the use of cloze tests it was unnecessary to indulge in second order inferences about the relationships between linguistic variables and comprehension difficulty. For example, when the relationship between word frequency and comprehension difficulty was examined, it was performed for each individual word as well as for the mean frequency of the words in passages.

Contributions from Psycholinguistics

The linguistic scientist has developed rigorous and objective descriptions of language. These have been sufficiently rigorous to permit psycholinguists to use them in the development of models of how people comprehend language. The word depth measure is one such model, the independent clause frequency measure is another.

CHAPTER II

OBJECTIVES

Form and Strength of the Relationships

The first objective was to determine the forms and strengths of the relationships between the linguistic variables and comprehension difficulty.

Linearity of Regression

A part of this objective was to find out whether the correlations between comprehension difficulty and each of the linguistic variables were linear. This was performed using an F test of linearity of regression. These tests were performed on all variables and at every level of analysis. Where a variable proved to have a curvilinear relationship with comprehension difficulty, the shape of this curve was plotted.

Variable Strength as a Function of Levels of Reading Achievement

The other part of this objective was to find out whether there was a change in the prediction power of the variables as the subjects advanced in reading achievement. Stated more exactly, this was the question, "When the comprehension difficulties are computed separately for groups at different levels of reading achievement, do the mean difficulties of the language units falling at either extreme on a linguistic variable differ significantly from the mean difficulty of the rest of the language units?"

Analyses Performed on All Variables

In addition to the analyses described above, all of the correlations between comprehension difficulty and the linguistic variables were tested for significance. Another test, of a sort, was provided by whether or not the variables entered into linear multiple correlations with comprehension difficulty. But, since the linearity of the correlations was in question, this could provide only a partial test.

Special Analyses of New Variables

The second general objective was to examine a group of new linguistic variables. A part of this analysis was to subject these variables to the analyses already described in stating the first general objective. A few of the new variables were subjected to special analyses because of questions that grew out of their rationales. The following paragraphs describe these special analyses.

Net Measures

Measures that were termed net number of syllables and net word depth were found for each independent clause and for each sentence. Net number of syllables was obtained by subtracting the number of words from the number of syllables in an independent clause or sentence. Net word depth was found by subtracting the number of words from the total depth of the independent clause or sentence. The question studied was whether this operation would result in correlations that were higher than those obtained from the original measures, that is, from total number of syllables and total word depth of independent clauses and sentences.

Words in Prepositional Phrases

Standard practice has been to count the number of prepositional phrases in a length of passage and to derive a proportion by dividing this number by the number of words in the passage. The present method is to count the number of words in prepositional phrases and then derive a proportion. The question studied was that of which method of quantifying prepositional phrases yielded the highest correlations with comprehension difficulty.

Independent Clause as the Unit of Syntactic Analysis

Traditionally, measures of the complexity of sentence syntax have used as the unit of analysis the sentence, which is usually defined by an initial capital letter and a terminal punctuation. The formally stated question was, "Do measures of syntactic complexity that are based upon the independent clause yield higher correlations with comprehension difficulty than measures that are obtained the same way but that are based upon the sentence?"

Number of Letters

Lengths of language units has been measured by finding the average number of syllables per word. A count of the number of letters in a language unit should yield a more precise measure of this dimension. The question studied was whether the numbers of letters in language units have higher correlations with comprehension difficulty than other measures of unit length.

Part of Speech Ratios

The ratio of adjectives to verbs has never been tested. Further, this is but one of the many possible ratios that can be found. Any effort to test hypotheses in this area immediately encounters the dispute between modern linguists and the traditional grammarians over just what constitutes a part of speech. As a result of these considerations, the following questions were studied:

1. Do any of the possible part of speech ratios correlate with the comprehension difficulty of passages when parts of speech are defined according to form class categories?
2. Do any of the possible part of speech ratios correlate with the comprehension difficulty of passages when parts of speech are classified according to the traditional classifications?
3. Are these correlations large enough to be of use in the prediction of comprehension difficulty?

Prediction of the Readability of Smaller Language Units

The third general objective was to test the feasibility of predicting the readabilities of small language units such as words, independent clauses, and sentences. The specific questions studied were the following:

1. Can significant correlations be obtained between comprehension difficulty and the linguistic variables at the word, independent clause, and sentence levels of analysis?
2. Are the correlations obtained at these levels of analysis large enough to permit accurate readability prediction?
3. What are the sizes of the linear multiple correlations attainable at these levels of analysis?

CHAPTER III

REVIEW OF RELATED RESEARCH

Validity of Cloze Tests

Dual Aspects of Cloze Test Validity

The validity of cloze tests as measures of the comprehension difficulty of written language is firmly established. This was done by demonstrating (1) that they are valid measures of comprehension ability and (2) that cloze test difficulties are valid measures of the difficulties of passages.

Validity as Measures of Comprehension Ability

Bormuth (1962) constructed pairs of tests, consisting of one cloze and one multiple-choice comprehension test, over each of nine passages, administered them to subjects in grades 4, 5, and 6, and found correlations ranging from .74 to .84 between the scores from each pair. When the scores were pooled to form a long and reliable test of each type, the correlation was .93. Finally, when the cloze scores were correlated with scores from tests measuring seven different kinds of comprehension, and when the correlations were then corrected for attenuation, all approached unity. Taylor (1957) found a correlation of .76 between a cloze and a multiple-choice test made from the same passage. Ruddell (1963) and Fletcher (1955) have found correlations in the same range between cloze and standardized reading comprehension tests.

Validity as Measures of Comprehension Difficulty

Taylor (1953) found a significant correlation between the cloze test difficulties of a set of passages and the readabilities of the passages as predicted from the Dale-Chall and Flesch formulas. Further, he found that the cloze tests measured elements of style which affect difficulty but to which the formulas are insensitive. Sukiori (1957) observed a correlation of .83 between the judged difficulties of a set of passages and their difficulties as measured by cloze tests. In the study by Bormuth a correlation of .92 was found between the difficulties of the passages as determined by the cloze and multiple-choice tests. Both Taylor and Bormuth found that the difficulties of their cloze tests had reliabilities of .97 or higher.

Forms of the Relationships

Linearity of the Correlations

Klare (1963) and Powers and Kearl (1958) have pointed out that researchers have nearly always assumed that their variables correlate linearly with comprehension difficulty but that none has tested this assumption. They further pointed out that, because of this failure, the actual sizes of the correlations may be much higher than is popularly supposed. Finally, they pointed out that some of the error in readability formulas may be due to our ignorance of the true forms of these relationships.

Evidence that these relationships are curvilinear is strongest as it relates to linguistic variables measuring vocabulary difficulty.

Seldom, if ever, is the relationship of such a variable found to be linearly related to a psychological measure of difficulty. For example, King-Ellison and Jenkins (1954) found that the length of time required for the recognition of a word has a hyperbolic relationship to the word's frequency. Lorge (1948) found a higher correlation between comprehension difficulty and word frequency when he simply found the proportions of words that were not on a list of highly frequent words than when he averaged the frequency indexes of the words in his passages. By reducing the word frequency scale to two values, zero and one, when he used his list of "easy" words, he threw away the information on the exact form relationship between the two variables. The fact that the loss of this information produced an increase in the correlation supports strongly the contention that the discarded information caused the regression to depart markedly from linearity.

A similar argument can be used to explain why—as shown by Klare's (1963) review of the research—the Lorge formula, which uses a short list of words, is a better predictor of the difficulties of easy materials and a poorer predictor of the difficulties of difficult materials than the Dale-Chall Formula which uses a longer list. If curvilinearity is assumed, these differences can be explained by the fact that each list predicts best in a different range along the curve.

Variable Strength as a Function of Levels of Achievement

Gray and Leary (1935) presented evidence that linguistic variables do not predict comprehension difficulty equally well for subjects who differ in levels of achievement. They determined the difficulties of a set of passages for two groups, a group of good readers and a group of poor readers. Of the 44 linguistic variables that were correlated with each set of difficulties, 32 correlated higher with the difficulties determined from the responses of the poor readers. The reverse was true of the remaining twelve variables. Though not all of these differences were significant, it was fairly certain that most changed with the levels of reading achievement of the subjects. Credibility is lent this argument by the fact that there was a definite pattern in these changes. Ten of the twelve correlations that increased with level of achievement involved measures of sentence complexity while the majority of those showing the reverse pattern could be classed as measures of word difficulty.

Linguistic Variables

New Variables

Word Depth. Bormuth (1963), using nine passages, found a correlation of .78 between the mean word depths of the passages and their comprehension difficulties. When the vocabulary difficulty and the mean sentence length of the passages were experimentally held constant, the correlation was .77.

Letter Redundancy. Carterette and Jones (1963) calculated the letter redundancy of samples of text drawn from elementary school textbooks at the first, second, third, and fifth grade levels. The measured redundancies of the passages correlated perfectly with the grade placements of these books.

Independent Clause Frequency. Ruddell (1963) wrote three pairs of passages. The passages in each pair were carefully matched for Dale-Chall readability, subject matter content, and writing style, but they differed in that one member of each pair was written using exclusively those clause patterns shown by Strickland (1962) to be highly frequent in the language of children. The other member of each pair was written using only patterns of low frequency. The passages containing the low frequency patterns were significantly more difficult to comprehend. The correlation between independent clause frequency and comprehension difficulty was .55.

Net Measures. No record was found of any research regarding the use of a net measure. This may be due to the fact that, until the present, all research has been forced to use the sentence level of analysis. At this level the net measure is not mathematically meaningful, since the same result can be obtained by simply subtracting the number one from mean syllables per sentence and mean depths of words.

Words in Prepositional Phrases. Lorge (1948) and Gray and Leary (1935) have each shown that the number of prepositional phrases and the number of words in sentences correlate with each other as highly as they correlate with comprehension difficulty. This suggests that a count of prepositional phrases measures the lengths of sentences. If this is true, a count of the numbers of words in prepositional phrases may be a still better measure of sentence length and hence a better predictor of comprehension difficulty.

Number of Letters. No record was found of any research in which a count of the number of letters was used to derive a linguistic variable. However, Flesch (1948) found that the average number of syllables per word had a correlation of .66 with comprehension difficulty. While Flesch theorized that this correlation was due to the fact that this variable measured the abstractness of words, it is equally possible to theorize that it was due to the fact that it measures word length. If so, a still better measure of word length could be obtained from counting the letters in a word. The same argument holds with respect to its use for measuring independent clause and sentence length.

Part of Speech Ratios. Two variables related to these ratios have been tested. Flesch (1950), in his quest for a measure of abstraction, defined what he called "definite words" which are actually a combination of subclassifications drawn from several part of speech categories. He found that it had a correlation of .55 with comprehension difficulty. The other instance is a count of the number of prepositional phrases per 100 words. Lorge (1948) found a correlation of .43 between this ratio and comprehension difficulty.

Established Variables

Word Frequency. Word frequency measures are usually taken from the index numbers assigned the words in Thorndike's (1931) and Thorndike and Lorge's (1944) studies. Lorge (1948) found a correlation of .51 between Thorndike's (1931) weighted word frequency and comprehension difficulty.

Number of Syllables. A count of the number of syllables has been used to measure both word length and sentence length. Flesch (1948) found a correlation of .66 between the mean number of syllables per word and comprehension difficulty. Gray and Leary (1935) found a correlation of .44 between average sentence length measured in syllables and comprehension difficulty.

Number of Words. A count of the number of words has been used almost exclusively for the measurement of average sentence length. Dale and Tyler (1934) found a correlation of .29 between mean number of words per sentence and comprehension difficulty. Gray and Leary (1935) found a correlation of .40 and Flesch (1940) a correlation of .47.

Words on the Dale List of 769 Words. Words not on this list are usually counted as hard words and the proportion of hard words in a passage is then found. Dale and Tyler (1934) found a correlation of .35 between the proportion of words that were on this list and comprehension difficulty. Gray and Leary (1935) found a correlation of .35 between the proportion of hard words and comprehension difficulty. Lorge (1948) found a correlation of .61 using a hard word count.

Words on the Dale List of 3,000 Familiar Words. Words on this list are used in the same manner as those on the list of 769 words. Dale and Chall (1948) found a correlation of .68 between the proportions of words not on this list and comprehension difficulty.

Prepositional Phrases. This count is made by counting the number of prepositional phrases per 100 words. Infinitives are not counted. Dale and Tyler (1934) and Gray and Leary (1935) each found correlations of .35 between this variable and comprehension difficulty. Lorge (1948) found a correlation of .43.

Readability Prediction at Lower Levels of Analysis

There is no precedent for the study of readability prediction using words, independent clauses, or sentences as the units of analysis. The reason is not hard to find. Before the development of the cloze test it was difficult or impossible to make a comprehension test that would satisfactorally measure the comprehension difficulties of these units.

CHAPTER IV

PROCEDURE

The procedure followed in this study consisted of (a) determining the comprehension difficulties of the language units; words, independent clauses, sentences, and passages, (b) obtaining linguistic variables by quantifying certain aspects of the language units, and then (c) analyzing in various ways the correlations between the comprehension difficulty of various language units and linguistic variables.

Measurement of Comprehension Difficulty

Subjects

Selection of the Sample. Subjects in this study comprised the entire enrollment in grades 4 through 8 in the Wasco Union Elementary School District in Wasco, California. This sample was chosen for its similarity to the general population of school children. The scores of these children on tests of academic achievement approximated those of the children in the standardizing populations. At the time of the experiment, the proportions of children from the various racial, occupational, and foreign language speaking backgrounds roughly approximated those of children in the nation as a whole. Further, the excellent cooperation of the school authorities made it possible to conduct the study under desirable conditions.

Form Groups. Using total scores on the California Reading Test, the group was subdivided into five groups having similar means and distributions of scores. This was done for one grade level at a time to insure that the subgroups contained approximately equal numbers of subjects enrolled at each grade level. These tests had been administered by the school about three months prior to the beginning of the testing for this experiment. During the experiment, an appropriate level of the Stanford Achievement Test: Reading, Form J, was administered to each subject and his total grade placement score obtained by averaging the two subtest scores. These scores were then used in the final matching of the groups after all of the testing was finished. Each group after the final matching, had the same number of subjects and similar means and distributions of total scores on this test. Subjects who had not taken all tests were excluded in these form groups. The between groups F ratio was .07 which was not significant.

Cloze Tests

Passages. Twenty passages consisting of about 275 words each were selected, four from each of the following subject matter areas of literature; history, geography, biological science, and physical science. Within each subject matter category, the passages selected were fairly evenly distributed in Dale-Chall readability from about the 4.0 to about the 8.0 grade level of difficulty. Care was taken to select passages that had not been previously read by the subjects. Appendix A contains the bibliographical data on these passages.

Cloze Test Construction. Five cloze test forms were made from each passage. A cloze test form was made by deleting every fifth word from the passage and replacing each with an underlined blank 15 spaces in length. No words were deleted in the first and last sentences of each passage. A word was taken, generally, as being defined by the white spaces that separated it from other words. That is, contractions (e.g. don't), abbreviations (e.g. U.S.A.), numbers (e.g. 2,102), and hyphenated words in which one of the segments was a bound form (e.g. re-enter) were deleted as if the whole unit constituted only a single word. On the other hand, the parts in hyphenated words where both parts were free forms (e.g. self-made) and in numbers that were written out (e.g. two hundred) were deleted as if each part of the unit were a separate word. Punctuation within words was deleted in all cases except where a hyphen seperated two free forms. When typing the tests for mimeographing, punctuation was spaced with respect to the first and last spaces of the underlining in exactly the way it would have been had these spaces been the first and last letters of a word. Appendix B contains the set of instructions given to the typist.

Five different forms of the cloze test over each passage were made in such a way that every word in a passage appeared as a deletion item in one of the forms. This was done by beginning the deletion process with a different word in each form. Thus, in one form, words 1, 6, 11, 16, . . . etc. were deleted, and in the next form, words 2, 7, 12, 17, . . . etc. were deleted, etc. until five such forms had been made. The different forms over each passage were given letter designations A through E.

Scoring the Cloze Tests. Cloze tests were scored using the exact word method. In this method a response is scored correct if the subject has written in the blank exactly the same word that was deleted to form that blank. Misspellings of a correct response were scored correct, if they did not make the response equivocal by spelling a homonym that could have fitted grammatically into the syntax of the sentence.

Testing Procedure

Preliminary Testing. On the first day of testing the subjects were given the Stanford Achievement Test: Reading using the instructions suggested in the manual. A sample cloze test consisting of about 20 items was also given for the purpose of instructing the subjects in how to take tests of this kind. Appendix C shows this test. The instructions were read to the subjects, they took the test, and then they scored their own responses. The test instructions were discussed as the items were scored. This test was devised in such a way that it illustrated all of the test rules.

Cloze Testing. On the second through the eleventh days of testing, the subjects took two cloze tests per day. The cloze tests for each session were compiled in booklets of two tests each. On the front of each booklet was stapled a copy of the test instructions. These were read to the subjects on each of the first two days of cloze testing. Subjects' questions during testing were answered by referring to the test instructions. The testing periods were 50 minutes in length. This period was sufficiently long so that no subject had to be stopped before he had finished the test.

Assignment of Test Forms to Form Groups. Each of the five test forms over a passage had been given a letter designation, A through E, and each of the form groups had been given similar letter designations. The subjects in each form group took only the forms of the cloze tests that had the same letter designation as the group. For example, subjects in form group A took only cloze test forms designated as the A forms.

Criterion Variable

Computation of Comprehension Difficulty

Word Difficulty (WOR DIF). The indices of the comprehension difficulties of language units; words, independent clauses, sentences, and passages, were each based upon what is here termed as word difficulty. Word difficulty was found by determining the proportion of subjects passing an item on a cloze test. This proportion was then transformed to make it additive using the transformation table from Davis (1949). This transformed proportion was taken as the index of the comprehension difficulty of the word deleted from that item. The responses of all 139 subjects from each of the form groups were used in these calculations.

Independent Clause Difficulty (IND CLAU DIF). The difficulties of independent clauses were found by calculating the mean of the word difficulties within each of them. The coordinate conjunction joining some of them was ignored.

Sentence Difficulty (SEN DIF). The difficulties of sentences were found by calculating the means of the word difficulties within each sentence.

Passage Difficulty (PAS DIF). The difficulties of passages were calculated by finding the mean of the word difficulties within the portion of each of the passages for which word difficulties had been found.

Difficulties Calculated for Ability Level Groups. Word, independent clause, sentence, and passage difficulties were calculated again, this time separately for the subjects in each of the five ability groups. Within each form group the subjects were ranked according to their total scores on the Stanford Achievement Test: Reading, quintile points determined, and then the subjects falling between the same set of quintile points placed in the same ability group. Table 1 shows the effects of this grouping procedure. An analysis of variance showed that there was a significant difference between ability groups but not between form groups. Interactions were not significant.

TABLE 1. ANALYSIS OF VARIANCES OF THE READING ACHIEVEMENT SCORES OF THE FORM AND ACHIEVEMENT GROUPS.

Table 1a. Analysis of Variances among Form and Ability Groups.*

Source	d. f.	Sums of Squares	Mean Squares	F ratio
Form Groups	4	51.06	12.77	.07
Achievement Groups	4	992,892.71	248,223.18	1,320.37
Form X Achievement	16	1,550.18	96.89	.52
Within	650	122,212.49	188.02	
Total	674	1,116,706.44		

*N = 675. Four subjects were discarded at random from each form group for this analysis.

Table 1b. Achievement and Form Group Means.

Achievement Group	Form Group A	B	C	D	E	Achievement Group Means
1	3.32	3.14	3.20	3.19	3.12	3.20
2	4.23	4.16	4.10	4.19	4.21	4.18
3	5.09	5.01	5.02	5.19	5.20	5.10
4	6.21	6.40	6.36	6.24	6.37	6.29
5	8.65	8.86	8.90	8.63	8.71	8.75
Form Group Means	5.50	5.51	5.49	5.49	5.52	

Linguistic Variables

Levels of Analysis

Linguistic variables were derived at each of four levels of analysis; the word, the independent clause, the sentence, and the passage level. For example, number of syllables yielded a number for each word, the number of syllables in the word; for each independent clause, the number of syllables in the clause; etc. Table 2 lists all of the variables studied at each of the preceding levels of analysis except the part of speech variables which were obtained only for the passage level. They are discussed separately.

TABLE 2. DEFINITIONS OF THE LINGUISTIC VARIABLES DERIVED FROM THE BASIC COUNTS AND CALCULATED FOR THE LANGUAGE UNITS AT EACH LEVEL OF ANALYSIS

Names of Variables	Levels of Analysis			
	Word (w)	Independent Clause (i)	Sentence (s)	Passage
Number of Letters (l)				
LET	l	l	l	--
LET/WOR		l/w	l/w	l/w
LET/IND CLAU				l/i
LET/SEN				l/s
Number of Syllables (y)				
SYL	y	y	y	--
SYL-WOR		y-w	y-w	--
SYL/WOR		y/w	y/w	y/w
SYL/IND CLAU				y/i
SYL/SEN				y/s
Word Depth (d)				
WOR DEP	d	--	--	--
ΣWOR DEP		Σd	Σd	--
ΣWOR DEP-WOR		Σd-w	Σd-w	--
ΣWOR DEP/WOR		Σd/w	Σd/w	Σd/w
ΣWOR DEP/SEN				Σd/s
Word Frequency Index (f)				
WOR FRE	f	--	--	--
ΣWOR FRE/WOR		Σf/w	Σf/w	Σf/w
Number of Prepositional Phrases (p)				
PREP PHR		p	p	--
PREP PHR/WOR				p/w
PREP PHR/IND CLAU				p/i
PREP PHR/SEN				p/s
Number of Words on Dale List of 769 Words (a)				
DL769/WOR		a/w	a/w	a/w

TABLE 2 (Continued)

Names of Variables	Levels of Analysis			
	Word (w)	Independent Clause (i)	Sentence (s)	Passage
Number of Words on Dale List of 3000 Words (*b*)				
DL3000/WOR		b/w	b/w	b/w
Number of Words (*w*)				
WOR		w	w	--
WOR/IND CLAU				w/i
WOR/SEN				w/s
Independent Clause Frequency (*c*)				
IND CLAU FRE		c	--	--
ΣIND CLAU FRE/IND CLAU			Σc/i	Σc/i
Number of Words in Prepositional Phrases (*q*)				
WOR PREP PHR/WOR		q/w	q/w	q/w
WOR PREP PHR/IND CLAU				q/i
WOR PREP PHR/SEN				q/s
Letter Redundancy (r)				
LET RED				r
LET RED$^{4}_{11}$				r^{4}_{11}

Number of Letters (*LET*). As its name implies, this variable was obtained by simply counting the number of letters used to write whatever language unit was being considered. Blank spaces and punctuation within words, such as apostrophes, hyphens, and commas, were not counted. In numbers written in Arabic numerals, each number was counted as being one letter. Table 2 shows that this counting operation was used to measure the lengths of words, independent clauses, and sentences and to obtain the mean number of letters per unit at the independent clause, sentence, and passage levels.

Number of Syllables (*SYL*). The number of syllables in a language unit was obtained by using *Webster's New Collegiate Dictionary* (1959) as the standard. The number of syllables in numbers written in Arabic numerals was obtained by counting the number of syllables when the number was spoken. In addition to using a count of the number of syllables to derive mean number of syllables per language unit, it was also used to derive what was called a "net" figure, that is, the number of syllables in a language unit minus the number of words in that unit.

Word Depth (WOR DEP). The procedure for obtaining a word's depth consists of two operations, (a) analyzing the syntactical structure of a sentence and (b) applying a counting operation to the syntactical relationships found in the sentence.

The method of syntactical analysis used in word depth analysis starts with a sentence, breaks it into subject and predicate, and then analyzes each of these parts into smaller and smaller units, stopping when the individual words have been reached. All grammatical divisions are binary. Figures 1a, 1b, and 1c show that the result of this analysis is a network of lines showing the relationships among the constituant structures at the various syntactic levels. A detailed description of this form of syntactical analysis is given in Nida (1960).

When the counting procedure performed upon the syntactical analysis is taken as a model of the way people produce and comprehend language, it involves at least three important assumptions which are used as rules governing the counting operations, (1) that people produce and comprehend sentences from left to right, (2) that they proceed from the larger structures and work down to the smaller structures, and (3) that, as they are producing or comprehending a structure, they keep in mind what structures remain unfinished. The number of

FIGURE 1

ILLUSTRATIONS OF WORD DEPTH ANALYSIS OF SENTENCES

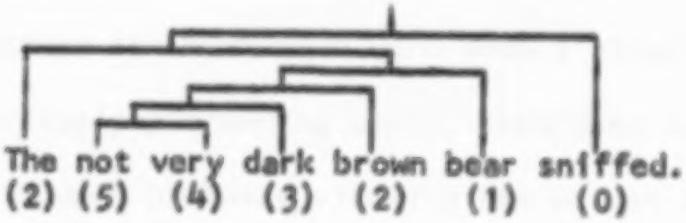

The not very dark brown bear sniffed.
(2) (5) (4) (3) (2) (1) (0)

Figure 1a. Syntactic and Word Depth Analysis of a Sentence Containing a "Regressive" Structure.

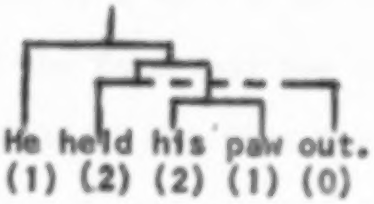

He held his paw out.
(1) (2) (2) (1) (0)

Figure 1b. Syntactic and Word Depth Analysis of a Sentence Containing a Discontinuous Constituant.

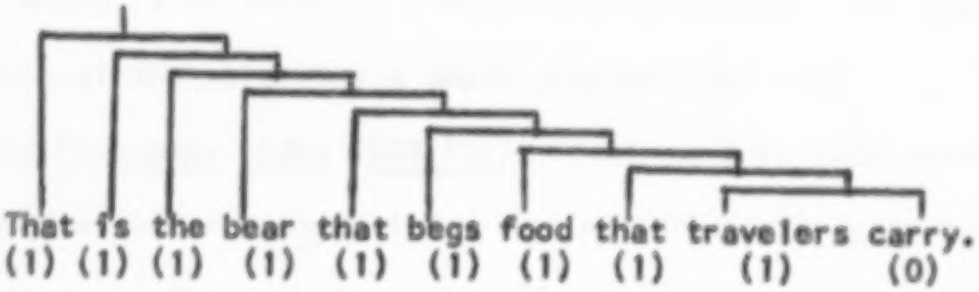

That is the bear that begs food that travelers carry.
(1) (1) (1) (1) (1) (1) (1) (1) (1) (0)

Figure 1c. Syntactic and Word Depth Analysis of a Sentence Containing "Progressive" Structures.

structures unfinished at the time that a word is read or produced is said to be the depth of that word.

Figure 1 illustrates how this analysis proceeds by showing how the counting is performed on three commonly encountered syntactic patterns. In Figure 1a the phrase "not very dark brown bear" is a "regressive" structure in which each word ends a structure that was begun by the immediately preceeding word. According to the model, the individual must work backward starting new phrase structures until, by the time the word "not" is produced, five structures have been begun but not completed.

Figure 1b illustrates what is known as a discontinuous constituant, the phrase "held . . . out." In such cases the two portions of the phrase are separated by a word or phrase. The counting procedure takes into account the fact that the completion of the phrase has not yet been accomplished at the time that "paw" and "his" are produced by assigning each a depth value one greater than they would have been assigned had the predicate read "held out his paw." Figure 1c shows a sentence made up of "progressive" structures in which all but the last word begin a new structure or are the last word in a structure which is followed by a modifying structure. For these reasons none of the words has a depth greater than one.

Word Frequency Index (WOR FRE). Each word in each passage was assigned a word frequency index number derived directly from the indices given in Throndike's (1944) The Teacher's Word Book of 30,000 Words. In this book are the combined results of several studies of the frequency with which words occur in written language. The words in this list have been ranked in the order of their frequencies, divided into groups according to this rank, and each word within a group assigned the same number. The numbers assigned to the different groups of words range from 1, for the group of words that occurred least frequently, to 49, A, and AA for the groups that occurred most frequently. For the present study this numbering system was extended by assigning an index number of zero to words which did not appear in the list and the numbers 50 and 51 to the words in A and AA groups, respectively. Table 2 shows that a word frequency index number was found for each word at the word level of analysis and that the mean of these indices was found for each language unit at each of the other levels of analysis.

Number of Prepositional Phrases (PREP PHR). The number of prepositional phrases was found in each independent clause and in each sentence. The ratio of prepositional phrases to words was found at each of these two levels. At the passage level, the ratios of prepositional phrases to independent clauses and to sentences were also found.

Number of Words on Dale List of 769 Words (DL769). Each word was classified as to whether or not it appeared on the Dale List of 769 Words. The number of words that appeared on this list was found for each independent clause, sentence, and passage. Table 2 shows that a ratio was then found between the number of words in a language unit that appeared on this list and total number of words in that language unit.

Number of Words on the Dale List of 3,000 Words (DL3,000). This list was used in exactly the same manner as the Dale List of 769 Words. Table 2 shows that the ratios were also obtained in an identical manner.

Number of Words (WOR). This variable was obtained simply by counting the words in a language unit. As shown in Table 2, these counts were used directly at the independent clause and sentence levels. At the passage level, mean words per sentence and mean words per independent clause were found.

Independent Clause Frequency (IND CLAU FRE). This variable was obtained using the frequencies of independent clause patterns reported by Strickland (1962). Strickland recorded the oral language of children using samples of children from each of the grade levels 1 through 6. She analyzed the grammatical pattern of each independent clause, classified it according to its type, and then tabulated separately for the children at each grade level, the frequency with which each clause pattern occurred.

The analysis of independent clause patterns in the passages was the same as that used by Strickland. The unit of analysis was the independent clause, which can be considered identical to Strickland's "syntactic unit." The analysis proceeded by first classifying the constituents of the independent clauses using the following coding scheme:

1	Subject, may include a word phrase or clause
2	Verb, verb phrase, or compound predicate
(2)	Auxiliary verb
2b	Verb of the "to be" or copulative type
3	Indirect object
4	Direct object
5	Predicate nominative
M_1	"There" group expressing place

M_2 "How/so" group expressing manner

M_3 "Then" group expressing time

M_4 "Because/if" group expressing purpose or cause

M_5 Indirect object introduced by a preposition

+ A coordinate conjunction

ƒ A conjunction joining causative subordination structure
to the rest of the sentence

U Utterence, a one word structure such as, "Yes"

T Symbol used to show that an independent clause was preceeded
or followed by another independent clause.

The pattern of an independent clause was defined by the code symbols and sequence of code symbols associated with it. For example, the sentence

$$\underset{1}{\underline{\text{The boy}}}\ \underset{2}{\underline{\text{walked}}}\ \underset{M_2}{\underline{\text{softly}}}\ \underset{+}{\underline{\text{but}}}\ \underset{T}{\underline{\text{we}}}\ \underset{2}{\underline{\text{caught}}}\ \underset{4}{\underline{\text{him}}}.$$

contains the two clause patterns, 1 2 M_2 + T and the pattern T + 1 2 4.

To obtain the frequency values associated with the independent clause patterns of various types, the tabulations of independent clause frequencies that Strickland reported for children in grades 1, 3, and 6 were combined by adding together the frequencies with which each pattern occurred in each of these subsamples. Each independent clause in the passages used in the present study was then assigned the number that represented the frequency of its pattern in the combined samples. Table 2 shows that independent clause frequency was used directly at the independent clause level of analysis and mean frequencies were found at the sentence and passage levels.

Number of Words in Prepositional Phrases (*WOR PREP PHR*). This variable was obtained by counting in each language unit the number of words that appeared in prepositional phrases. A ratio of these words to the total number of words in the language unit was computed for each language unit at the independent clause, sentence, and passage levels of analysis. At the passage level, ratios were found between the number of words and the number of independent clauses and sentences in each passage.

Letter Redundancy (*LET RED*). The method for calculating letter redundancy used, as the unit of analysis, the letters and punctuation of the passages and yielded a single redundancy measure for each passage. These calculations were identical to a part of those used by Carterette and Jones (1963). The major portion of the analysis of the passages was performed using a computer program that they developed for the IBM 7090 computer. The symbols included the 26 letters of the alphabet, the blank space used to spell the termini of words and a symbol used to spell the termini of sentences. Each adjacent pair of symbols was tabulated in a contingency table to find the number of times each symbol followed each of the other symbols. The first and second members of these pairs were at varying distances from each other. This lag of the second member varied from the first to the tenth symbol to the right of the first member of a pair. Ten separate tables were calculated for each passage, one for each step of lag. Letter frequency, zero lag, could be determined from any of the tables. The probability with which each letter, $p_i(0)$, occurred was determined from the frequency, f_i, of the letter by

$$p_i(0)=\frac{f_i}{n},$$

and the probability with which each pair of letters, $p_{i,j}$, calculated separately at each of the ten, k, steps of lag, was found from the frequency of the pair, $f_{i,j}$, by

$$p_{i,j}(k)=\frac{f_{i,j}}{n} ,$$

where n was equal to the number of symbols in a passage, N, minus the greatest lag, K, used in tables. That is n=N-K.

From these probabilities, the Shannon-Weiner measure of information was calculated. These calculations, which yield a measure of the information transmitted by a sequence of signals in terms of bits, were

$$H = -\sum_{i=1}^{m} p_i \log_2 p_i ,$$

where m is the number of symbols in the coding system, in this case 28.

The measure of the amount of information found in pairs of symbols was obtained by the double summation

$$H_{i,j} = \sum_i \sum_j p(i,j) \log_2 p(i,j).$$

The Miller and Madow (1954) correction was used to obtain an unbiased estimate of H. The formula is

$$H_{(\text{unbiased})} = H + \log_2 e \frac{m-1}{2n} - \frac{\log_2 e}{12 n^2} + \frac{\log_2 e}{12 n^2} \sum_{i=1}^{m} \frac{1}{p_i} \cdot$$

Only unbiased H values were used in all further calculations.

Using the McGill and Garner (1956) formula, the conditional information in the second letter of a pair that is dependent upon the choice of a first letter, T(i,k), was calculated by

$$T(0,k) = 2H(0) - H(0,k).$$

The letter redundancy of each passage was then calculated over each of the steps of lag by

$$r = \frac{\sum_{k=1}^{m} T(0,k)}{H(0)}.$$

Part of Speech Variables

Classification Categories. Each word was classified into a part of speech category on the basis of its usage in its context. Two classification schemes were used. One was the eight parts of speech of traditional grammar. The other was five of Fries (1953) form classes, 1, 2, 3, 4, and his structural words, S. For this study, all structural words, form classes A through O, were placed in a single category and labeled as class S words. The procedure followed in classifying the words was to construct first an exhaustive set of classifications that could be grouped in one way to form the five form classes. By breaking down the traditional parts of speech into subclasses, such a set was obtained. Table 3 presents a list of these categories. After the name of each sub-class is the name of the traditional category and the form class into which it falls. All classification of words was done by a trained linguist.

Ratios. In each passage the number of words belonging to each of the part of speech categories was found. Ratios were then found between each of the 64 possible pairs of these numbers and between each part of speech and total number of words. A second set consisting of 25 ratios was found, this time based on the numbers of words in each of the form classes.

TABLE 3. THE PART OF SPEECH SUB-CLASSES, THE TRADITIONAL PART OF SPEECH CATEGORIES, AND THE FORM CLASSES USED IN CLASSIFYING WORDS IN THE PASSAGES

Sub-Classes	Traditional Parts of Speech	Form Classes
Noun	Noun	1
Personal Pronoun	Pronoun	1
Possessive Pronoun	Pronoun	s
Interrogative Pronoun	Pronoun	s
Demonstrative Pronoun	Pronoun	1
Indefinite Pronoun	Pronoun	1
Conjunctive Pronoun	Pronoun	s
Verb	Verb	2
Auxiliary Verb	Verb	s
"Do" Verb	Verb	s
Negative	Adverb	s
Simple Adverb	Adverb	4
Number Adverb	Adverb	s
Degree Adverb	Adverb	s
Introducer (there)	Adverb	s
Preposition	Preposition	s
Verbal Preposition	Preposition	s
Coordinate Conjunction	Conjunction	s
Subordinate Conjunction	Conjunction	s
Descriptive Adjective	Adjective	3
Ordinal Adjective	Adjective	4
Cardinal Adjective	Adjective	s
Article and Determiner	Adjective	s
Nominal Adjective	Adjective	3
Possessive Nominal Adjective	Adjective	3
Interjection	Interjection	s

CHAPTER V

ANALYSIS AND FINDINGS

Linearity of the Relationships

Method of Analysis

The first question was whether the linguistic variables were linearly related to comprehension difficulty. The purpose of investigating this problem was to find out what types of mathematical treatments can appropriately be given to linguistic variables in readability predictions. This analysis was partially a statistical and partially a graphical analysis. An F test of linearity was calculated for the relationship between each of the linguistic variables and comprehension difficulty.

Limitations of the F Test

Care was taken in the calculations of the F tests of linearity to avoid one of the problems that arises from the fact that their calculations involve the use of the eta correlation ratios. In the calculation of eta the cases (the language units) are divided into class intervals according to their values on the dependent variable (comprehension difficulty). For the cases in each interval the mean of the independent variable (linguistic variable) values was found. The variances of the cases around their class means were then used to calculate eta. Only one eta was calculated for each distribution, and this eta was for the regression of the linguistic variable upon comprehension difficulty. Both of these were expedients dictated by the large number of calculations involved and the limitations of funds with which to conduct them. However the objective of determining the shapes of the relationships was not altered by these expedients.

One problem that can arise stems from the fact that the size of eta is affected if the number of class intervals is allowed to approach the numbers of cases in the total sample. This became a problem chiefly at the passage level of analysis where there were only 20 cases. Conversely, when the number of class intervals becomes very small, the differences between intervals are averaged out and the size of the eta is accordingly diminshed. Therefore, to obtain a reliable estimate of eta, there should also be enough intervals to represent adequately the range.

In these analyses 15, 10, and 5 class intervals were used in the calculation of the etas at the word, independent clause, and passage levels of analysis, respectively. These numbers of classes maximized the numbers of cases in each class and represented roughly equal ranges of comprehension difficulty. These intervals were approximately eight points on the comprehension difficulty scale at all but the word level where the interval was about five points. This narrower range was possible because of the great numbers of cases in each interval.

Interpretation of Negative F Values

A peculiarity of the F test of linearity is the fact that negative F values can occur when the size of the Pearson product moment correlation exceeds the size of the eta. This happens fairly often when the relationship is linear. Negative F values in this study were interpreted as meaning that the relationships for which they occurred were linear.

The results of the F tests of linearity are shown in Tables

4, 5, and 6. Each table shows the Pearson product moment correlation (the r) and the eta correlation ratio (the eta) between comprehension difficulty and each of the linguistic variables. Figures 2 and 3 show each of the curvilinearly related linguistic variables plotted against comprehension difficulty.

Word Level of Analysis

At the word level of analysis each word was analyzed with respect to four linguistic variables. Each of these sets of numbers was correlated with the comprehension difficulties of the words to obtain eta and r coefficients. Table 4 shows these correlations along with the F ratios. These F ratios have 14 and 5,166 degrees of freedom, making an F of 1.64 significant at the .05 level. A significant F ratio indicates that the relationship was not linear.

TABLE 4. PEARSON PRODUCT MOMENT AND ETA CORRELATIONS OF WORD DIFFICULTY WITH EACH OF THE LINGUISTIC VARIABLES AND THE F RATIOS OBTAINED FROM THE TESTS OF LINEARITY (N=5,181).

Name of Variable	r	eta	F*
SYL	395	426	12.29
LET	498	520	12.26
WOR FRE	286	334	13.42
WOR DEP	002	058	1.34

*F ratios of 1.64 or greater are significant at the .05 level where F has 14 and 5,166 degrees of freedom.

It can be seen from this table that all but word depth were curvilinear. The correlations involving word depth were so small as to be of doubtful significance.

An examination of figure 2 shows that short words were the easiest, whether word length was measured in letters or syllables. Increases in difficulty were associated with gradual increases in word length until the words reached average lengths of about 1.4 syllables or 4.4 letters. Beyond these points similar increments in difficulty are associated with a sharp increase in word length. Stated differently, increases in word length have the greatest effect upon comprehension difficulty when the words are short to begin with. However, after they have exceeded a certain length, much greater increments in word length are required to produce the same amount of increase in difficulty.

Word frequency follows the same general pattern. Small decreases in the frequency indices are associated with steady increases in the difficulties of the words until an average frequency index of about 47 is reached. After this point a larger drop in average frequency is required to produce a similar amount of increase in difficulty.

Independent Clause Level of Analysis

At the independent clause level of analysis values were found for each independent clause on 15 linguistic variables. The difficulty of each clause was determined by averaging the difficulties of the words within it. The relationships between the linguistic variables and comprehension difficulty were then analyzed in the same manner as those at the word level.

FIGURE 2. Plots Showing the Mean Linguistic Variable Values of the Language Units Falling in Successive Intervals of Comprehension Difficulty, Calculated for Variables Derived at the Word Level of Analysis.

Figure 2a. Number of Syllables

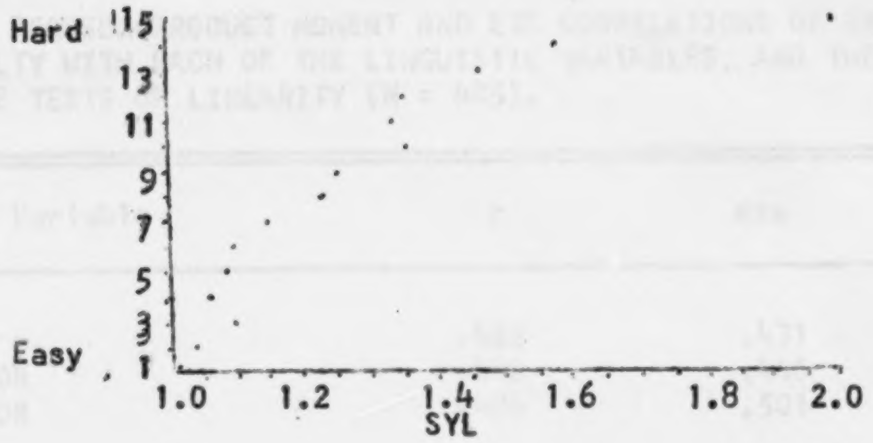


Figure 2b. Number of Letters

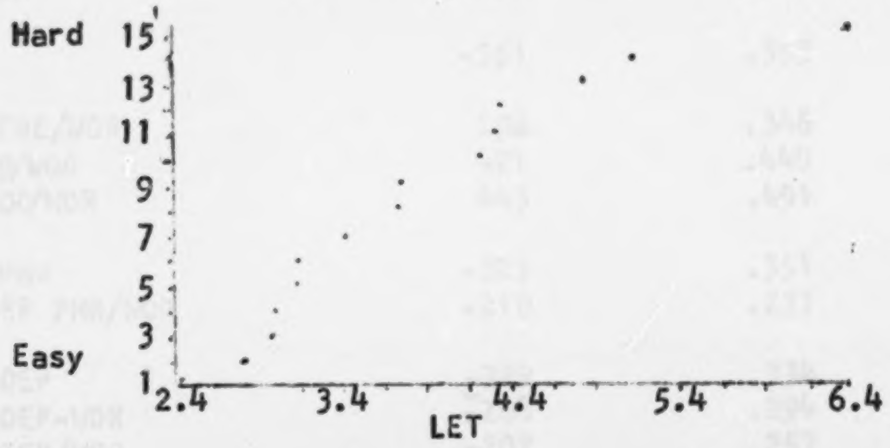


Figure 2c. Word Frequency

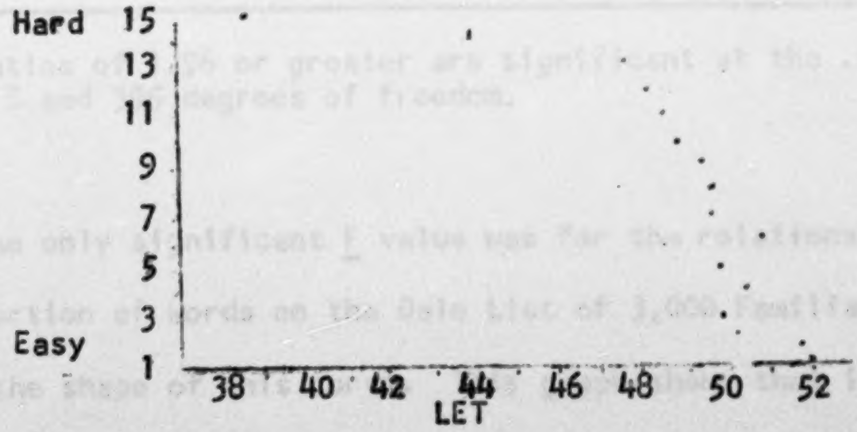


Table 5 shows the *r* and eta correlations and the F ratios from the tests of linearity. These *F* ratios have 8 and 395 degrees of freedom. They are significant at the .05 level if they equal or exceed 1.96.

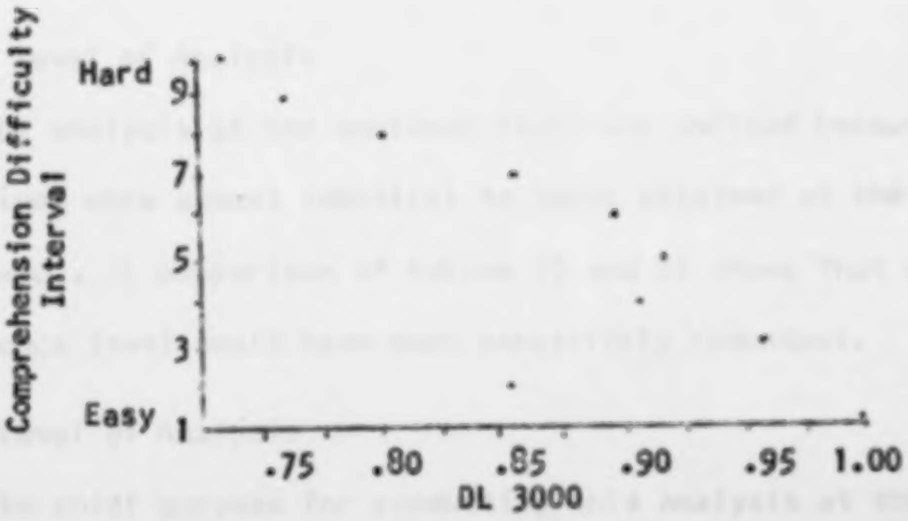
TABLE 5. PEARSON PRODUCT MOMENT AND ETA CORRELATIONS OF INDEPENDENT CLAUSE DIFFICULTY WITH EACH OF THE LINGUISTIC VARIABLES, AND THE *F* RATIOS OBTAINED FROM THE TESTS OF LINEARITY (N = 405).

Name of Variable	r	eta	F*
SYL	-422	.431	.49
SYL/WOR	-448	.446	-.13
SYL-WOR	-484	.501	1.11
LET	-427	.434	.40
LET/WOR	-553	.547	.47
WOR	-351	.359	.35
ΣWOR FRE/WOR	298	.346	1.76
DL 769/WOR	421	.448	1.47
DL 3000/WOR	443	.491	2.89
PREP PHR	-323	.351	1.05
WOR DEP PHR/WOR	-210	.271	1.57
ΣWOR DEP	-329	.334	.20
ΣWOR DEP-WOR	-288	.294	.17
ΣWOR DEP/WOR	-202	.257	1.34
IND CLAU FRE	049	.115	.54

*F ratios of 1.96 or greater are significant at the .05 level where *F* has 8 and 395 degrees of freedom.

The only significant *F* value was for the relationship involving the proportion of words on the Dale List of 3,000 Familiar Words. Figure 3 shows the shape of this curve. This graph shows that independent clauses containing the lowest proportions of these words were most difficult to comprehend. Increase in the proportions were associated with gradual

FIGURE 3. PLOT SHOWING THE MEAN OF THE LINGUISTIC VARIABLE VALUES OF THE PASSAGES FALLING IN SUCCESSIVE INTERVALS OF COMPREHENSION DIFFICULTY, CALCULATED FOR THE RELATIONSHIP BETWEEN THE PROPORTION OF WORDS ON THE DALE LIST OF 3000 FAMILIAR WORDS AND COMPREHENSION DIFFICULTY.



decreases in difficulty. When the proportions reached about .9, further decreases were associated with sharp drops in difficulty. The scatter of the points in the last three intervals can be explained as being due to the small numbers of cases in those intervals.

It was noted that average word frequencies, letters, and syllables were linear on this level of analysis while they were curvilinear at the word level. This fact can be explained in that at the independent clause level these variables are actually averages. When numbers which are themselves skewed are averaged, the distribution of these averages usually approximates a normal distribution. The relationships between normally distributed variables are almost always linear.

Sentence Level of Analysis

The analysis at the sentence level was omitted because the correlations were almost identical to those attained at the independent clause level. A comparison of tables 19 and 21 shows that an analysis at the sentence level would have been excessively redundant.

Passage Level of Analysis

The chief purpose for conducting this analysis at the passage level was to determine the forms of the relationships of variables that had not appeared at lower levels of analysis. In no case did the F ratio reach 3.29, the level required to reach significance at the .05 level with 3 and 15 degrees of freedom. Table 6 shows these ratios along with the Pearson product moment and eta correlations.

It was of interest to note that the relationship involving words on the Dale List of 3,000 words approached being curvilinear at this level also. However, a rough plot of this relationship showed no similarity to the curve found at the independent clause level of analysis.

TABLE 6. PEARSON PRODUCT MOMENT AND ETA CORRELATIONS OF PASSAGE DIFFICULTY WITH EACH OF THE LINGUISTIC VARIABLES, INCLUDING THE RATIOS OBTAINED FROM THE FORM CLASSES, AND THE F RATIOS OBTAINED FROM THE TESTS OF LINEARITY (N=20).

Conventional Variables

Names of Variables	r		F*
SYL/WOR	-625	683	.72
SYL/IND CLAU	-800	783	-.35
SYL/SEN	-696	677	-.25
LET/WOR	-675	759	1.43
LET/IND CLAU	-807	794	-.28
LET/SEN	-673	660	-.16
PREP PHR/WOR	-412	497	.51
PREP PHR/IND CLAU	-724	755	.53
PREP PHR/SEN	-753	741	-.21
WOR PREP PHR/WOR	-456	474	.10
WOR PREP PHR/IND CLAU	-704	710	.08
WOR PREP PHR/SEN	-724	703	-.30
ΣWOR FRE/WOR	537	658	1.27
DL 769	676	743	1.07
DL 3000	638	788	2.82
WOR/IND CLAU	-769	732	-.61
WOR/SEN	-582	569	-.11
ΣWOR DEP/WOR	-546	500	-.32
ΣWOR DEP/SEN	-502	490	-.00
IND CLAU FRE/IND CLAU	130	313	.45
LET RED$_4$	350	644	2.49
LET RED$_{11}$	-377	618	1.94

*F ratios of 3.29 or greater are significant at the .05 level where F has 3 and 15 degrees of freedom.

TABLE 6 (Continued)

Form Class Ratios**

Names of Variables	r		F*
noun/all other, 1/a	489	623	1.22
verb/noun, 2/1	127	237	.21
adjective/noun, 3/1	-606	708	1.34
adverb/noun, 4/1	098	463	1.30
structural/noun, 5/1	-659	676	.21
noun/verb, 1/2	-190	300	.30
verb/all other, 2/A	494	492	-.01
***adjective/verb, 3/2	-573	559	-.12
adverb/verb, 4/2	070	544	2.06
structural/verb, 5/2	-564	555	-.07
noun/adjective, 1/3	548	696	1.79
verb/adjective, 2/3	576	671	1.08
adjective/all other, 3/A	-561	650	.93
adverb/adjective, 4/3	457	665	2.10
structural/adjective, 5/3	369	554	1.23
noun/adverb, 1/4	-144	467	1.26
verb/adverb, 2/4	-117	513	1.69
adjective/adverb, 3/4	-343	495	.35
adverb/all other, 4/A	228	538	1.67
structural/adverb, 5/4	-216	430	.85
noun/structural, 1/5	674	672	-.03
verb/structural, 2/5	666	629	-.39
adjective/structural, 3/5	-390	548	1.05
adverb/structural, 4/5	366	588	1.62
structural/all other, 5/A	-692	658	-.40

**For convenience, these ratios have been stated using the names of conventional parts of speech; however, the reader is warned that the correspondance between the two types of classifications is very inexact.

***This ratio corresponds almost exactly to Boder's (1940) adjective/verb ratio.

TABLE 6 (Continued)

Names of Variables	r		F**
Noun/all other	065	407	.97
Pronoun/noun	232	342	.36
Verb/noun	200	427	.87
Adverb/noun	214	357	.47
Preposition/noun	-458	415	-.23
Conjunction/noun	-333	473	.71
Adjective/noun	-363	516	.91
Interjection/noun	613	693	1.02
Noun/pronoun	-357	399	.19
Pronoun/all other	393	394	.01
Verb/pronoun	-357	354	-.01
Adverb/pronoun	-132	358	.63
Preposition/pronoun	-442	478	.21
Conjunction/pronoun	-524	510	-.10
Adjective/pronoun	-469	461	-.04
Interjection/pronoun	619	704	1.11
Noun/verb	-281	417	.58
Pronoun/verb	305	311	.02
Verb/all other	421	472	.29
Adverb/verb	115	405	.90
Preposition/verb	-457	535	.54
Conjunction/verb	-566	542	-.19
Adjective/verb****	-479	495	.10
Interjection/verb	613	694	1.02
Noun/adverb	-314	426	.50
Pronoun/adverb	-013	390	.89
Verb/adverb	-199	423	.85
Adverb/all other	334	440	.51
Preposition/adverb	-392	450	.31
Conjunction/adverb	-512	573	.49
Adjective/adverb	-435	490	.33
Interjection/adverb	626	714	1.21

****This ratio is not identical to Boder's (1940). Boder's adjective-verb ratio included only certain types of verbs and adjectives. The adjective-verb ratio given in the Form Class Ratios is nearly identical to his.

TABLE 6 (Continued)

Names of Variables	r	eta	F**
Noun/preposition	535	458	-.48
Pronoun/preposition	469	454	-.09
Verb/preposition	513	488	-.16
Adverb/preposition	438	476	.22
Preposition/all other	-421	476	.32
Conjunction/preposition	-153	402	.83
Adjective/preposition	211	494	1.32
Interjection/preposition	550	601	.46
Noun/conjunction	564	606	.39
Pronoun/conjunction	805	852	1.41
Verb/conjunction	727	743	.26
Adverb/conjunction	663	680	.21
Preposition/conjunction	215	356	.46
Conjunction/all other	-441	516	.49
Adjective/conjunction	304	526	1.27
Interjection/conjunction	607	685	.95
Noun/adjective	365	608	1.88
Pronoun/adjective	392	391	-.00
Verb/adjective	432	477	.26
Adverb/adjective	471	493	.14
Preposition/adjective	-112	529	1.86
Conjunction/adjective	-251	401	.58
Adjective/all other	-430	489	.35
Interjection/adjective	582	646	.68
Noun/interjection	533	695	1.93
Pronoun/interjection	541	703	2.00
Verb/interjection	532	694	1.92
Adverb/interjection	552	714	2.08
Preposition/interjection	442	602	1.31
Conjunction/interjection	522	685	1.84
Adjective/interjection	484	646	1.57
Interjection/all other	598	671	.84

Variable Strength as a Function of Levels of Reading Achievement

Purpose

The question posed in this part of the analysis was whether the strength of each variable changed as a function of the level of reading achievement of the subjects. Stated somewhat differently, the question was whether linguistic variables continue to contribute to comprehension difficulty as the reading abilities of subjects increase. The reason for studying this question was to find out if the same linguistic variables and the same readability formulas can be used to predict readability for subjects who differ in reading achievement.

Method of Analysis

Rationale. The method of analysis selected was based on the reasoning that a linguistic variable no longer contributes to comprehension difficulty when, for subjects at a given level of reading achievement, the groups of language units at either extreme of a linguistic variable do not differ in comprehension difficulty from each other or from the group of language units having medial values. Correlations of the type used by Gray and Leary (1935) do not provide a sufficient analysis for this question. The size of a correlation is dependent on both the strength of the relationships between the variables and on the variance among the cases on the variables being correlated. Since there was no practical way to control the variances of the linguistic and comprehension difficulty variables, relative sizes of the correlations would have been uninterpretable if they had been used with these data.

Procedure. The first step in the analysis was to divide the subjects into five levels according to the sizes of their scores on the Stanford reading test. The divisions were made at the quintile points in such a way that exactly 27 subjects from each form group were placed at each achievement level. Table 3 shows the mean grade placement score of the subjects in each of these levels of achievement. From these scores it can be seen that the groups ranged in ability from a very low to a fairly mature level of reading achievement.

The second step consisted of stratifying the language units into three levels according to the sizes of their values on the linguistic variables. This was done separately for each linguistic variable. The numbers of language units in each category were as nearly equal as possible. These groups were labeled high, middle, and low. The label of high was given to the group of language units having the highest values on the linguistic variable by which the units were classified.

The third step was to calculate separately for each ability group the comprehension difficulty of each of the language units. That is, five sets of comprehension difficulties were obtained, one for the group at each ability level.

The fourth step was to perform an analysis of variance on the comprehension difficulties to see if the high, middle, and low thirds on each linguistic variable differed significantly. A multiple range test was also applied to find out which pairs of categories differed significantly. This analysis was performed separately for each achievement level group and for each variable. The calculations were performed using the BMD07V from Dixon (1964).

Interpretation. These data were analyzed by finding the achievement levels, if any, at which the language units in each of the thirds ceased to differ from each other significantly. Tables 7, 8, 9, and 10 show the F ratios obtained for each achievement level on each variable at each level of analysis. The differences among the three means were also plotted. These are shown in Figures 4, 5, and 6. Trends in the differences between the means can be detected in these graphs.

Word Level

Table 7 shows the data obtained at the word level of analysis. The names of the variables are shown in the left hand margin, and the achievement level of the group is shown in the second column. The numbers 1 to 5 in the second column correspond to the achievement levels shown in Table 3. That is, 1 stands for the group at the lowest level of achievement and 5 for the group at the highest. The F ratios appear in the third column. In the three columns to the right are the results of the tests of the significance of the difference between thirds of the language units.

Figure 4 shows the plots of the differences between mean difficulties of words in the upper, middle, and lower thirds with respect to their values on each of the linguistic variables. The points representing the differences between means are plotted directly above the achievement groups.

The F ratios obtained from all of the variables were significant for the subjects at each of the achievement levels. Further, the differences between the means were of approximately equal sizes for each of the achievement groups. It was also noted that the word depth variable

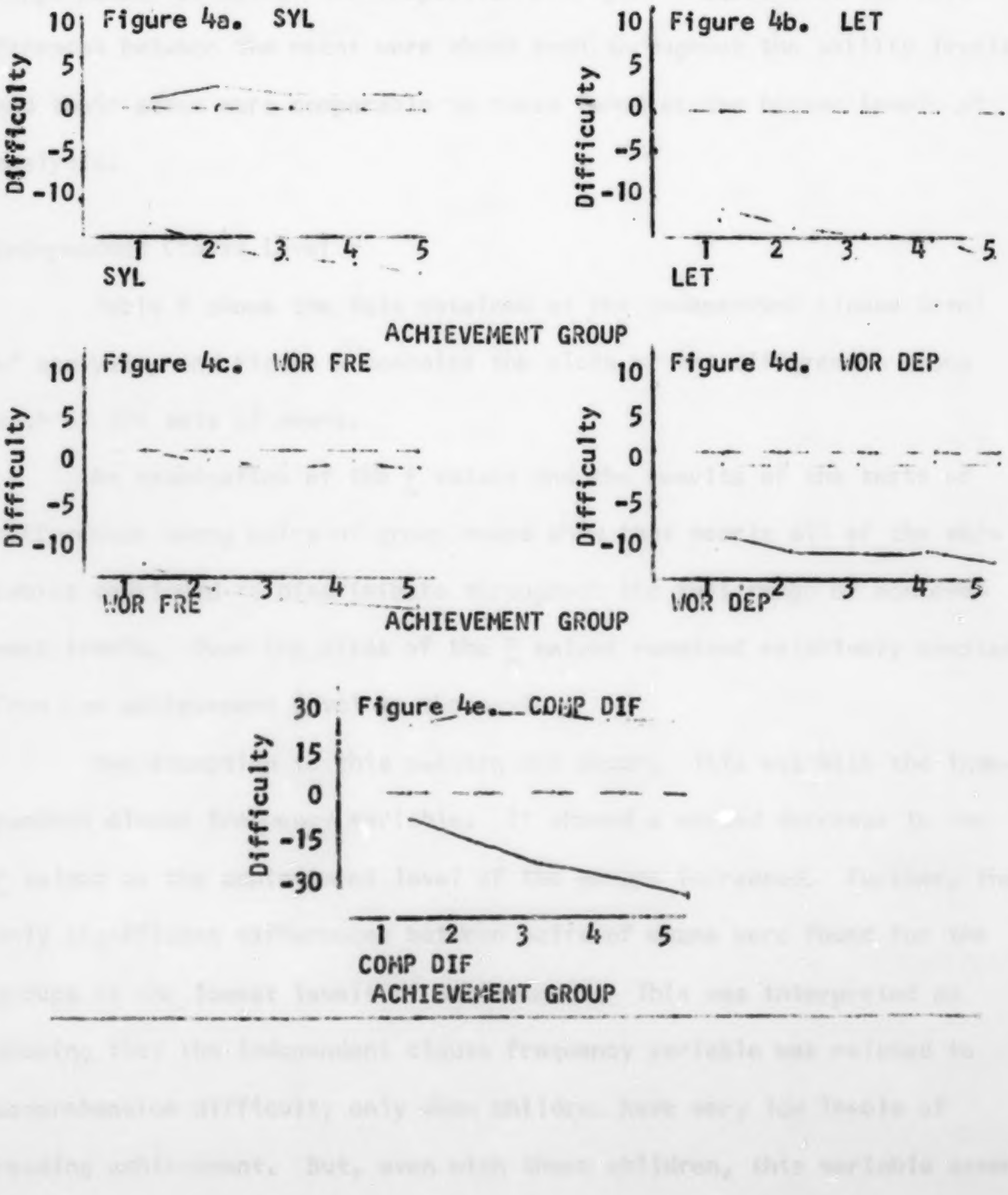
TABLE 7. ANALYSIS OF VARIANCE AND MULTIPLE RANGE TEST OF THE WORD DIFFICULTIES OF WORDS IN THE HIGH, MIDDLE, AND LOW THIRDS ON EACH LINGUISTIC VARIABLE.

Names of Variables	Ability Groups	F Ratio* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
SYL	1	430.18	YES	YES	YES
	2	455.03	YES	YES	YES
	3	483.29	YES	YES	YES
	4	450.58	YES	NO	YES
	5	444.83	YES	NO	YES
LET	1	839.32	YES	YES	YES
	2	811.65	YES	YES	YES
	3	816.18	YES	YES	YES
	4	762.20	YES	YES	YES
	5	717.63	YES	YES	YES
WOR FRE	1	305.94	NO	YES	YES
	2	378.17	NO	YES	YES
	3	390.41	NO	YES	YES
	4	370.27	NO	YES	YES
	5	383.54	NO	YES	YES
WOR DEP	1	84.67	NO	YES	YES
	2	79.64	NO	YES	YES
	3	66.93	NO	YES	YES
	4	58.36	NO	YES	YES
	5	54.70	NO	YES	YES
COMP DIF	1	5572.42	YES	YES	YES
	2	9011.55	YES	YES	YES
	3	12000.17	YES	YES	YES
	4	13432.39	YES	YES	YES
	5	12353.11	YES	YES	YES

*F ratios having 2 and 5,179 degrees of freedom are significant at the .05 level if they equal or exceed 2.99.

**Differences that reached the .05 level were considered significant.

FIGURE 4. VARIATIONS OF THE MEAN DIFFICULTIES OF THE WORDS IN THE UPPER AND LOWER THIRDS ON EACH LINGUISTIC VARIABLE ABOUT THE MEAN DIFFICULTY OF THE WORDS IN THE MIDDLE THIRD EXPRESSED IN DIFFICULTY UNITS.



proved to have a small but significant relationship to comprehension difficulty in this analysis. The high *F* ratios were a result of the large number of cases. An inspection of Figure 4 shows that the differences between the means were about even throughout the ability levels and their sizes were comparable to those found at the higher levels of analysis.

Independent Clause Level

Table 8 shows the data obtained at the independent clause level of analysis, and Figure 5 contains the plots of the differences among each of the sets of means.

An examination of the *F* values and the results of the tests of differences among pairs of group means show that nearly all of the variables continued to discriminate throughout the full range [illegible]ement levels. Even the sizes of the *F* values remained rela[illegible] constant from one achievement level to the next.

One exception to this pattern did occur. This was with the independent clause frequency variable. It showed a marked decrease in the *F* values as the achievement level of the groups increased. Further, the only significant differences between pairs of means were found for the groups at the lowest levels of achievement. This was interpreted as showing that the independent clause frequency variable was related to comprehension difficulty only when children have very low levels of reading achievement. But, even with these children, this variable seemed to have only a slight relationship to comprehension difficulty.

Sentence Level

This analysis was not run at the sentence level. The sentence

TABLE 8. ANALYSIS OF VARIANCE AND MULTIPLE RANGE TEST OF THE INDEPENDENT CLAUSE DIFFICULTIES OF INDEPENDENT CLAUSES IN THE HIGH, MIDDLE, AND LOW THIRDS ON EACH LINGUISTIC VARIABLE.

Names of Variables	Ability Groups	F Ratios* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
SYL	1	48.33	YES	YES	YES
	2	53.05	YES	YES	YES
	3	52.64	YES	YES	YES
	4	42.75	YES	YES	YES
	5	35.81	YES	YES	YES
SYL/WOR	1	43.57	YES	YES	YES
	2	48.51	YES	YES	YES
	3	45.37	YES	YES	YES
	4	37.94	YES	YES	YES
	5	27.48	YES	YES	YES
SYL- WOR	1	60.32	YES	YES	YES
	2	70.58	YES	YES	YES
	3	70.62	YES	YES	YES
	4	58.93	YES	YES	YES
	5	50.10	YES	YES	YES
LET	1	51.73	YES	YES	YES
	2	57.07	YES	YES	YES
	3	58.90	YES	YES	YES
	4	46.32	YES	YES	YES
	5	40.78	YES	YES	YES
LET/WOR	1	70.97	YES	YES	YES
	2	71.31	YES	YES	YES
	3	66.58	YES	YES	YES
	4	59.41	YES	YES	YES
	5	51.00	YES	YES	YES
WOR	1	35.85	YES	YES	YES
	2	40.58	YES	YES	YES
	3	41.99	YES	YES	YES
	4	34.97	YES	YES	YES
	5	30.54	YES	YES	YES
ΣWOR FRE/WOR	1	17.99	YES	NO	YES
	2	21.47	YES	NO	YES
	3	23.37	YES	NO	YES
	4	23.50	YES	YES	YES
	5	23.23	YES	YES	YES

TABLE 8.(Continued)

Names of Variables	Ability Groups	F Ratios* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
DL 769	1	34.49	YES	YES	YES
	2	42.16	YES	YES	YES
	3	38.62	YES	YES	YES
	4	33.82	YES	YES	YES
	5	26.06	YES	YES	YES
DL 3000	1	33.93	YES	YES	YES
	2	43.25	YES	YES	YES
	3	45.20	YES	YES	YES
	4	45.43	YES	YES	YES
	5	40.94	YES	YES	YES
PREP PHR	1	12.57	YES	NO	YES
	2	14.55	YES	NO	YES
	3	15.61	YES	NO	YES
	4	13.50	YES	NO	YES
	5	11.79	YES	NO	YES
WOR PREP PHR	1	6.61	NO	YES	YES
	2	6.58	NO	YES	YES
	3	8.33	NO	YES	YES
	4	8.12	NO	YES	YES
	5	8.52	NO	YES	YES
ΣWOR DEP	1	21.47	YES	YES	YES
	2	22.76	YES	YES	YES
	3	24.18	YES	YES	YES
	4	19.47	YES	YES	YES
	5	17.24	YES	YES	YES
ΣWOR DEP-WOR	1	23.40	YES	YES	YES
	2	26.26	YES	YES	YES
	3	26.25	YES	YES	YES
	4	22.59	YES	YES	YES
	5	19.93	YES	YES	YES
ΣWOR DEP/WOR	1	23.36	YES	YES	YES
	2	26.26	YES	YES	YES
	3	26.25	YES	YES	YES
	4	22.59	YES	YES	YES
	5	19.93	YES	YES	YES

TABLE 8 (CONTINUED

Names of Variables	Ability Groups	F Ratios between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
IND CLAU FRE/IND CLAU	1	3.33	NO	NO	YES
	2	3.83	NO	YES	YES
	3	2.35	NO	NO	NO
	4	2.09	NO	NO	NO
	5	2.25	NO	NO	NO
COMP DIF	1	412.51	YES	YES	YES
	2	641.73	YES	YES	YES
	3	816.45	YES	YES	YES
	4	896.89	YES	YES	YES
	5	772.15	YES	YES	YES

*F ratios having 2 and 402 degrees of freedom are significant at the .05 level, if they equal or exceed 3.00.

**Differences that reached the .05 level were considered significant.

FIGURE 5. VARIATIONS OF THE MEAN DIFFICULTIES OF THE INDEPENDENT CLAUSES IN THE UPPER AND LOWER THIRDS ON EACH LINGUISTIC VARIABLE ABOUT THE MEAN DIFFICULTY OF THE INDEPENDENT CLAUSES IN THE MIDDLE THIRD EXPRESSED IN DIFFICULTY UNITS.

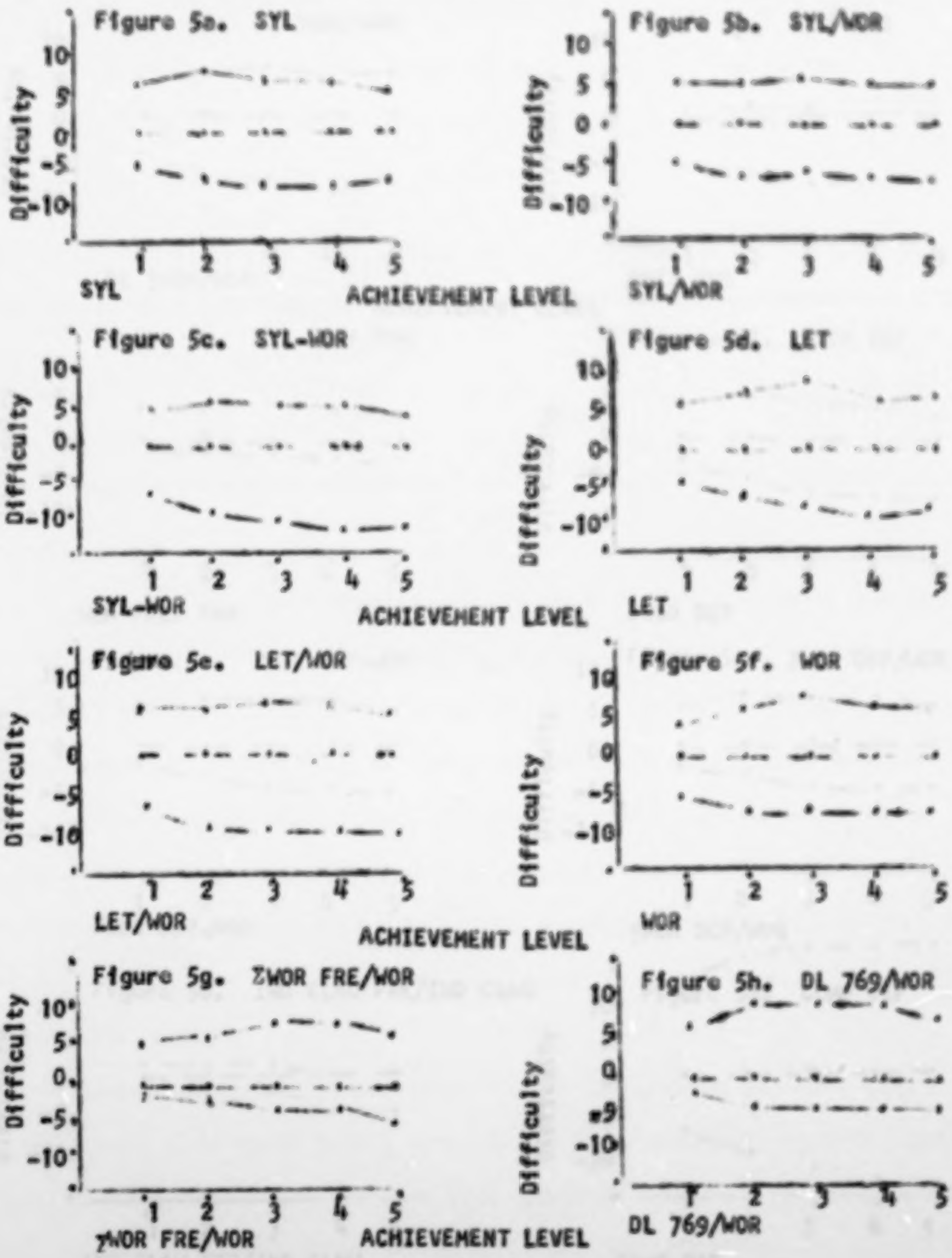
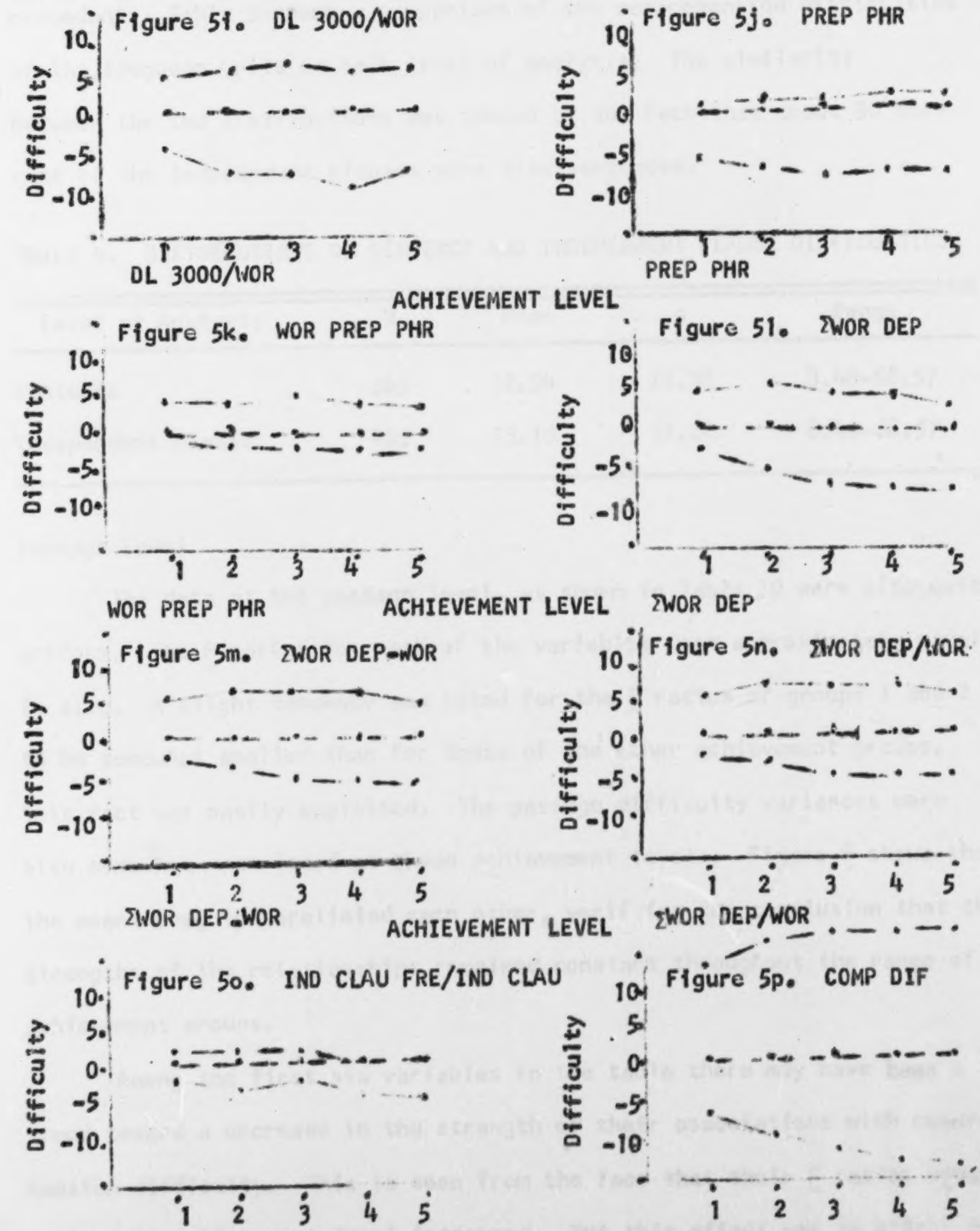


FIGURE 5. (continued)



and independent clause levels of analysis were so nearly identical that performing this analysis at both levels would have been excessively redundant. Table 9 shows a comparison of the comprehension difficulties of the language units on each level of analysis. The similarity between the two distributions was caused by the fact that about 90 percent of the independent clauses were also sentences.

TABLE 9. DISTRIBUTIONS OF SENTENCE AND INDEPENDENT CLAUSE DIFFICULTIES.

Level of Analysis	N	Mean	s	Range
Sentence	365	32.54	11.98	8.40-68.57
Independent Clause	405	33.10	12.24	8.40-68.57

Passage Level

The data at the passage level, as shown in Table 10 were also quite uniform. The F ratios for each of the variables were approximately equal in size. A slight tendency was noted for the F ratios of groups 1 and 2 to be somewhat smaller than for those of the other achievement groups. This fact was easily explained. The passage difficulty variances were also somewhat restricted at these achievement levels. Figure 6 shows that the means roughly paralleled each other, verifying the conclusion that the strengths of the relationships remained constant throughout the range of achievement groups.

Among the first six variables in the table there may have been a trend toward a decrease in the strength of their associations with comprehension difficulty. This is seen from the fact that their F ratios became smaller as achievement level increased. But this effect was so slight that it was impossible to be certain that it existed at all.

TABLE 10. ANALYSIS OF VARIANCE AND MULTIPLE RANGE TEST OF THE PASSAGE DIFFICULTIES OF PASSAGES IN THE HIGH, MIDDLE, AND LOW THIRDS ON EACH OF THE LINGUISTIC VARIABLES.

Names of Variables	Ability Groups	F Ratios* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
SYL/WOR	1	9.53	NO	YES	YES
	2	10.09	NO	YES	YES
	3	8.68	NO	YES	YES
	4	7.63	NO	YES	YES
	5	6.15	NO	YES	YES
SYL/IND CLAU	1	7.25	NO	YES	YES
	2	8.06	NO	YES	YES
	3	8.84	YES	NO	YES
	4	7.50	YES	NO	YES
	5	7.56	YES	NO	YES
SYL/SEN	1	12.00	NO	YES	YES
	2	12.87	NO	YES	YES
	3	15.42	NO	YES	YES
	4	15.26	NO	YES	YES
	5	14.24	NO	YES	YES
LET/WOR	1	9.55	NO	YES	YES
	2	9.96	NO	YES	YES
	3	8.46	NO	YES	YES
	4	7.27	NO	YES	YES
	5	5.99	NO	YES	YES
LET/IND CLAU	1	7.55	NO	YES	YES
	2	7.84	NO	YES	YES
	3	8.25	NO	YES	YES
	4	6.96	NO	NO	YES
	5	6.29	NO	NO	YES
LET/SEN	1	12.00	NO	YES	YES
	2	12.87	NO	YES	YES
	3	15.42	NO	YES	YES
	4	15.26	NO	YES	YES
	5	14.24	NO	YES	YES
PREP PHR/WOR	1	1.05	NO	NO	NO
	2	1.34	NO	NO	NO
	3	1.36	NO	NO	NO
	4	1.40	NO	NO	NO
	5	1.63	NO	NO	NO

TABLE 10 (Continued)

Names of Variables	Ability Groups	F Ratios* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
PREP PHR/IND CLAU	1	6.68	NO	YES	YES
	2	7.68	NO	NO	YES
	3	9.25	YES	NO	YES
	4	9.64	YES	NO	YES
	5	9.56	YES	NO	YES
PREP PHR/SEN	1	6.94	NO	NO	YES
	2	7.42	NO	NO	YES
	3	8.60	NO	NO	YES
	4	8.89	NO	NO	YES
	5	7.92	NO	NO	YES
WOR PREP PHR/WOR	1	1.90	NO	NO	NO
	2	2.55	NO	NO	YES
	3	2.87	NO	NO	YES
	4	3.01	NO	NO	YES
	5	2.95	NO	NO	YES
WOR PREP PHR/IND CLAU	1	6.68	NO	YES	YES
	2	7.68	NO	NO	YES
	3	9.25	YES	NO	YES
	4	9.64	YES	NO	YES
	5	9.56	YES	NO	YES
WOR PREP PHR/SEN	1	5.77	NO	YES	YES
	2	6.12	NO	YES	YES
	3	7.09	NO	YES	YES
	4	7.22	NO	NO	YES
	5	6.65	NO	NO	YES
ΣWOR FRE/WOR	1	4.80	NO	NO	YES
	2	6.04	NO	NO	YES
	3	5.64	NO	NO	YES
	4	6.22	NO	NO	YES
	5	6.71	NO	YES	YES
DL 769/WOR	1	8.43	NO	NO	YES
	2	10.00	NO	NO	YES
	3	8.76	NO	NO	YES
	4	7.53	NO	NO	YES
	5	5.83	NO	NO	YES

TABLE 10.(Continued)

Names of Variables	Ability Groups	F Ratios* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
DL 3000/WOR	1	4.53	NO	NO	YES
	2	5.93	NO	YES	YES
	3	5.97	NO	YES	YES
	4	6.80	NO	YES	YES
	5	6.00	NO	YES	YES
WOR/IND CLAU	1	5.07	NO	YES	YES
	2	5.17	NO	YES	YES
	3	5.90	NO	YES	YES
	4	5.23	NO	NO	YES
	5	5.57	NO	NO	YES
WOR/SEN	1	4.70	NO	NO	YES
	2	4.85	NO	NO	YES
	3	5.70	NO	NO	YES
	4	4.86	NO	NO	YES
	5	5.32	YES	NO	YES
ΣWOR DEP/WOR	1	6.27	NO	YES	YES
	2	7.26	NO	YES	YES
	3	7.19	NO	YES	YES
	4	8.06	NO	YES	YES
	5	10.0	NO	YES	YES
ΣWOR DEP/SEN	1	5.07	NO	YES	YES
	2	5.17	NO	YES	YES
	3	5.90	NO	YES	YES
	4	5.23	NO	NO	YES
	5	5.57	NO	NO	YES
IND CLAU FRE/IND CLAU	1	1.09	NO	NO	NO
	2	.81	NO	NO	NO
	3	.65	NO	NO	NO
	4	.44	NO	NO	NO
	5	.37	NO	NO	NO
LET RED_4	1	1.20	NO	NO	NO
	2	1.06	NO	NO	NO
	3	1.18	NO	NO	NO
	4	1.24	NO	NO	NO
	5	1.58	NO	NO	NO

TABLE 10 (Continued)

Names of Variables	Ability Groups	F Ratios* between Groups	Significant Differences Between Thirds**		
			HI vs MID	MID vs LO	HI vs LO
LET RED$_{11}$	1	1.75	NO	NO	NO
	2	1.85	NO	NO	NO
	3	1.94	NO	NO	NO
	4	1.94	NO	NO	NO
	5	1.77	NO	NO	NO
pn/conj	1	4.59	YES	NO	YES
	2	3.92	NO	NO	YES
	3	4.31	YES	NO	YES
	4	3.80	NO	NO	YES
	5	3.77	NO	NO	YES
adj/v, 3/2	1	2.34	NO	NO	NO
	2	2.52	NO	NO	NO
	3	2.91	NO	NO	YES
	4	3.11	NO	NO	NO
	5	3.18	YES	NO	NO
COMP DIF	1	26.68	YES	YES	YES
	2	31.87	YES	YES	YES
	3	41.17	YES	YES	YES
	4	51.30	YES	YES	YES
	5	42.86	YES	YES	YES

*F ratios having 2 and 17 degrees of freedom are significant at the .05 level, if they equal or exceed 3.59.

**Differences that reached the .05 level were considered significant.

FIGURE 6. VARIATIONS OF THE MEAN DIFFICULTIES OF THE PASSAGES IN THE UPPER AND LOWER THIRDS ON EACH LINGUISTIC VARIABLE ABOUT THE MEAN DIFFICULTY OF THE SENTENCES IN THE MIDDLE THIRD EXPRESSED IN DIFFICULTY UNITS.

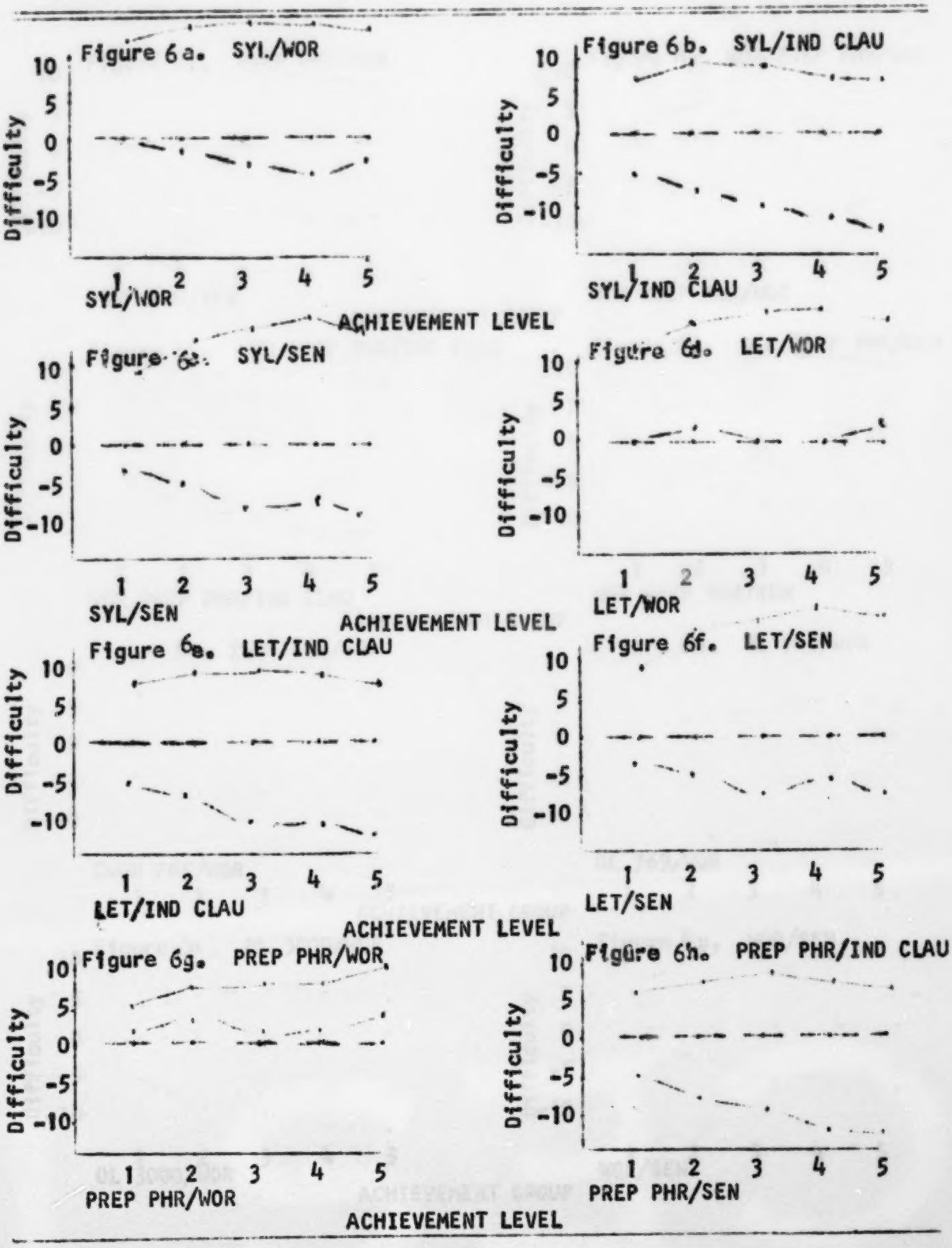


Figure 6 (continued)

Figure 6i. PREP PHR/SEN

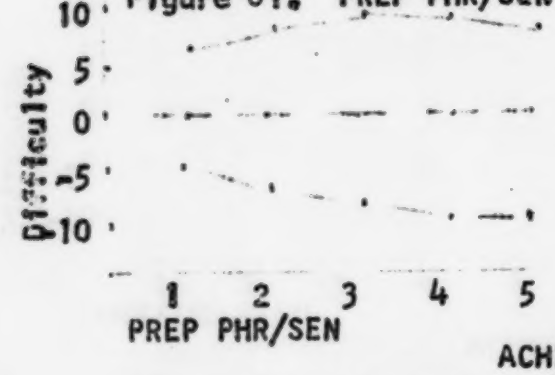
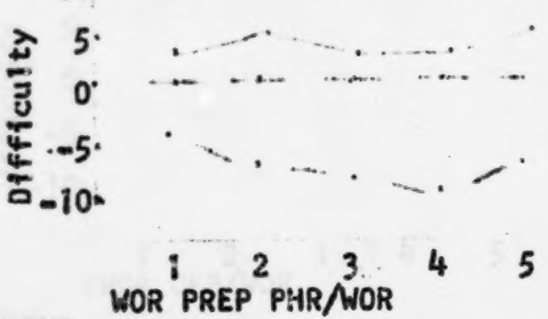


Figure 6j. WOR PREP PHR/WOR



ACHIEVEMENT GROUP

Figure 6k. WOR PREP PHR/IND CLAU

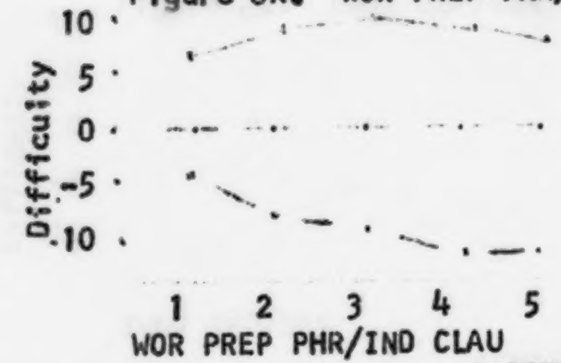
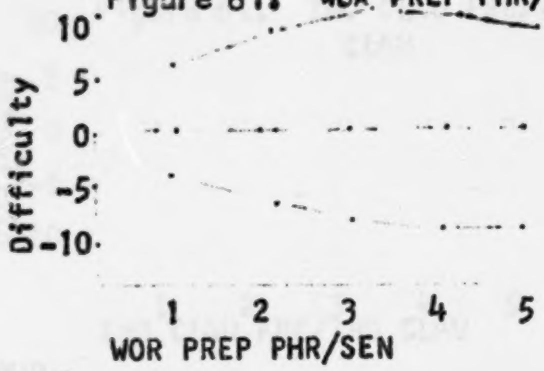


Figure 6l. WOR PREP PHR/SEN



ACHIEVEMENT GROUP

Figure 6m. ΣWOR FRE/WOR

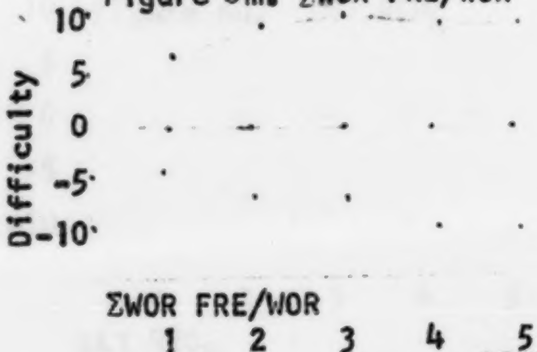
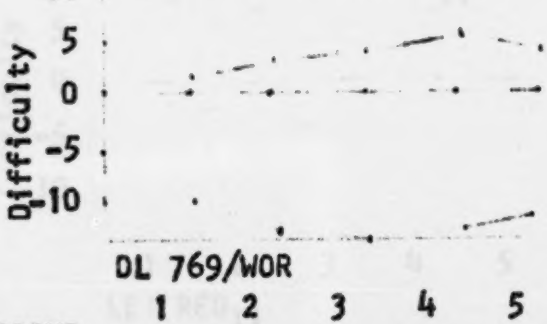


Figure 6m. DL 769/WOR



ACHIEVEMENT GROUP

Figure 6o. DL 3000/WOR

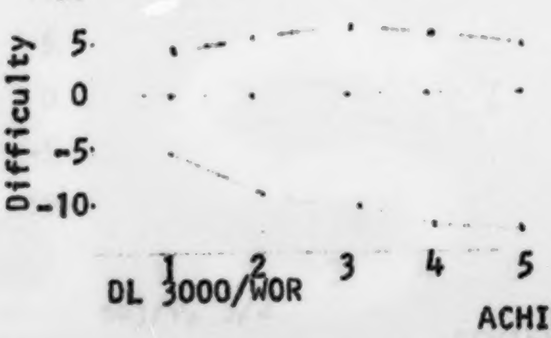
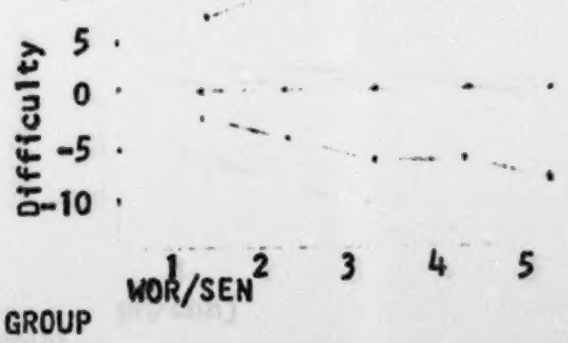


Figure 6p. WOR/SEN



ACHIEVEMENT GROUP

FIGURE 6 (continued)

Figure 6q. WOR/IND CLAU

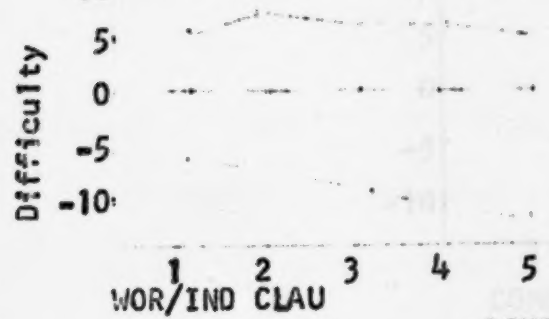
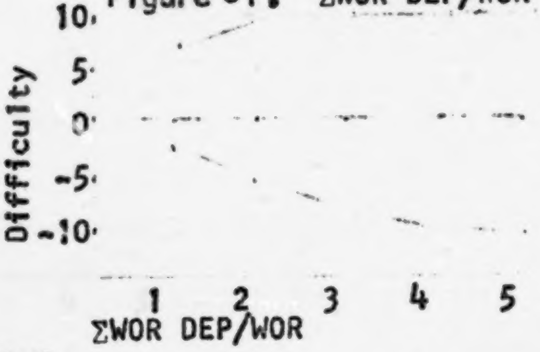


Figure 6r. ΣWOR DEP/WOR



ACHIEVEMENT GROUP

Figure 6s. ΣWOR DEP/SEN

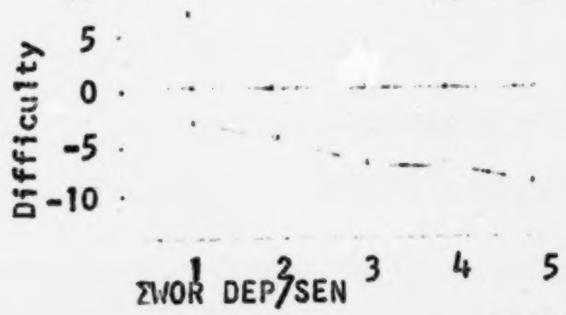
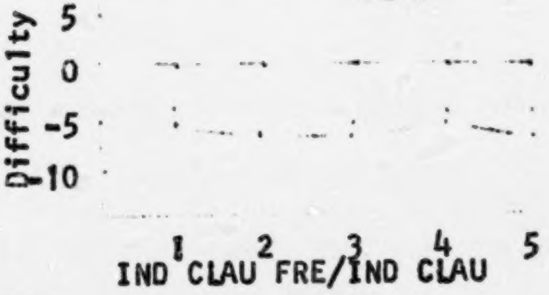


Figure 6t. IND CLAU FRE/IND CLAU



ACHIEVEMENT GROUP

Figure 6u. LET RED$_4$

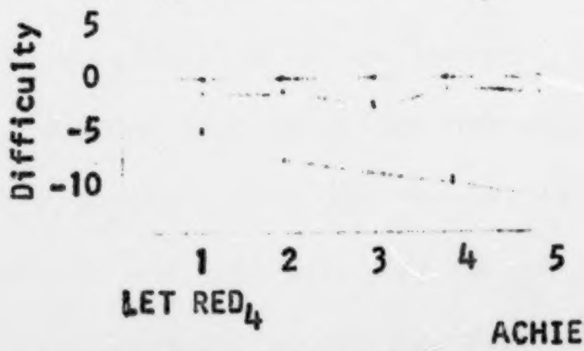
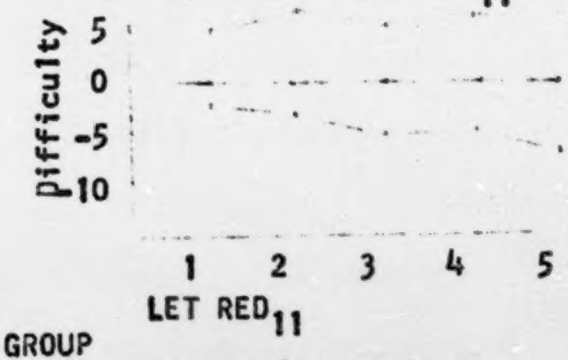


Figure 6v. LET RED$_{11}$



ACHIEVEMENT GROUP

Figure 6w. adj/v, 3/2

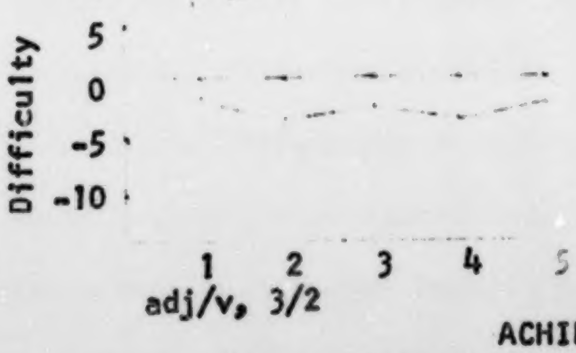
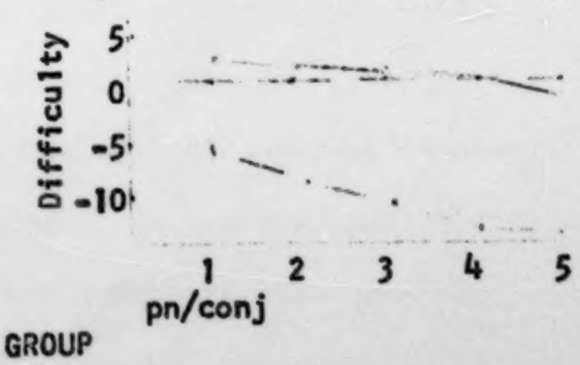


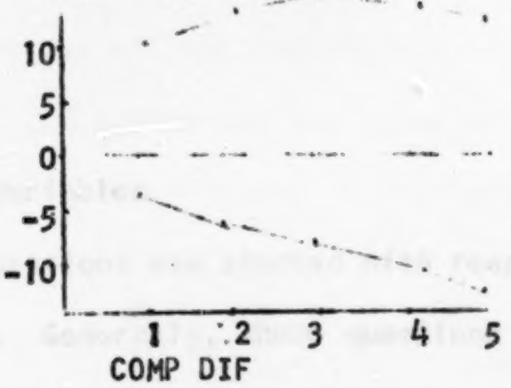
Figure 6x. pn/conj



ACHIEVEMENT GROUP

FIGURE 6. (continued)

Figure 6y. COMP DIF



New Variables

Contrasts of Similar Variables

A number of questions was studied with respect to comparisons of pairs of variables. Generally, these questions asked which of two variables yielded the highest correlation with comprehension difficulty. The purpose of these questions was to find variables that would furnish more accurate predictions of comprehension difficulty.

The statistical tests performed here tended to underestimate the significance of the differences observed. This particular analysis proceeds by computing the standard error of the difference between the pair of correlations being compared. The correlations are transformed to Fisher Z's and the difference between the Z's found. The difference is then divided by the standard error to obtain a critical ratio. This procedure underestimates the significance of the difference between correlations that are themselved correlated. Since each of the correlations was obtained from the same samples of subjects and language, there were strong grounds for believing that the correlations were themselves highly correlated. At present there is no satisfactory way to test the differences between correlated correlations. Consequently, many of the differences reported here may be significant even though these tests make it appear that they are not. In drawing conclusions, the author relied more heavily upon his own judgement than upon the results of the statistical tests.

Net and Total Measures

The question studied here was which yielded the higher correlation, net number of syllables and net word depth or total number of syllables and total word depth. Table 11 shows the comparisons of the correlations obtained for the net and total measures at the independent clause and sentence levels of analysis. None of the differences was significant according to the test used. Further, in absolute terms the differences were not large.

TABLE 11. COMPARISONS OF THE SIZES OF THE CORRELATIONS WITH COMPREHENSION DIFFICULTY THAT WERE OBTAINED FROM THE NET AND TOTAL MEASURES OF WORD DEPTH AND NUMBER OF SYLLABLES IN INDEPENDENT CLAUSES AND SENTENCES.*

Names of Variables	Pearson Product Moment			
	Net	Total	Z Diff	CR
Independent Clause				
SYL	-.48	-.42	.078	1.10
WOR DEP	-.29	-.33	-.045	.64
Sentence				
SYL	-.51	-.46	.062	.71
WOR DEP	-.29	-.34	-.061	.70

*None of the differences in this table was significant.

Prepositional Phrases and Words in Prepositional Phrases

The question studied here was which yielded the higher correlation, a count of the number of prepositional phrases or a count of the number of words in prepositional phrases. Table 12 shows these correlations at the passage level of analysis. The counts were turned into ratios by dividing them by words, independent clauses, and sentences. The differences between the correlations yielded by these ratios were neither large nor consistent. It seems likely that the two types of counts yield nearly identical results.

TABLE 12. COMPARISONS OF THE SIZES OF THE CORRELATIONS WITH COMPREHENSION DIFFICULTY THAT WERE OBTAINED FROM THE NUMBER OF PREPOSITIONAL PHRASES AND WORDS IN PREPOSITIONAL PHRASES AT THE PASSAGE LEVEL OF ANALYSIS.*

Names of Denominators	Pearson Product Moment			
	Numerators			
	WOR PREP PHR	PREP PHR	Z Diff	CR
--/WOR	-.46	-.41	.054	.16
--/IND CLAU	-.70	-.72	-.041	.12
--/SEN	-.72	-.75	-.064	.19

*None of the differences in this table was significant.

Independent Clause and the Sentence

The question studied here was which yielded the higher correlation, variables based upon the independent clause or variables based upon the sentence as the unit of language analysis. Table 13 shows the comparisons of the variables derived at the passage level of analysis. The variables in this table seem to fall into two groups. Those measuring length, the variables having letters, syllables, and words in the numerators, seemed to have consistently larger correlations when they were based upon the independent clause. Further, the differences were large. In spite of the fact that the critical ratio was not large enough to be significant, it seemed likely that the differences were reliable.

TABLE 13. COMPARISON OF THE SIZES OF THE CORRELATIONS WITH COMPREHENSION DIFFICULTY THAT WERE OBTAINED FROM THE VARIABLES BASED ON THE SENTENCE AND ON THE INDEPENDENT CLAUSE AS THE UNIT OF SYNTACTIC ANALYSIS AT THE PASSAGE LEVEL.*

Names of Numerators	Pearson Product Moment			
	Denominators			
	IND CLAU	SEN	Z Diff	CR
LET/--	-.81	-.67	.257	.76
SYL/--	-.80	-.70	.239	.70
WOR/--	-.77	-.58	.352	1.04
PREP PHR/--	-.72	-.75	-.064	-.19
WOR PREP PHR/--	-.70	-.72	-.041	-.12

*None of the differences in this table was significant.

With measures of complexity, involving prepositional phrases or words in prepositional phrases, the differences were much smaller and in the opposite direction. Since these differences were very small, it seemed likely that they may have occurred by chance.

Thus, measures of unit length based upon the independent clause seemed to be superior to those based upon the sentence. When the ratios contained prepositional phrases or words in prepositional phrases in the numerator the correlations appeared to be identical.

Comparisons of Letters with Syllables and Words as Measures of Length

The question studied here was which yields the highest correlations with comprehension difficulty, measures of unit length based upon letters or measures based upon syllables and words. In other words, the variable based on letters was being compared with each of the other two units used to measure the lengths of words, independent clauses, and sentences. Table 14 shows the results of these comparisons. The numbers for which these correlations were found were actually ratios, the numerators of which appear in the left hand margin of the table and the denominators of which appear in the headings of the columns. Comparisons were made only between ratios that had identical numbers in their denominators. In the table this meant that comparisons were made only between correlations that were obtained at the same level of analysis and that appeared in the same column. The Z differences and critical ratios appear to the right on the same line with the correlation involving syllables or words.

The results of this analysis showed that the count of the number of letters in words produced higher correlations than the count of the number of syllables in words. Though this difference was greatest at the word level of analysis, it remained large at all of the other levels of analysis.

The count of the numbers of letters in independent clauses and sentences yielded correlations that were about equal to those obtained from the count of the number of syllables in these units. Counts of both the letters and the syllables in independent clauses and sentences produced generally higher correlations than those obtained from counts of the numbers of words in these units.

TABLE 14. COMPARISONS OF THE SIZES OF THE CORRELATIONS, WITH COMPREHENSION DIFFICULTY, THAT WERE OBTAINED FROM THE VARIABLES BASED ON THE LETTER AND THE OTHER TWO MEASURES OF UNIT LENGTH, THE SYLLABLE AND THE WORD.

Names of Numerators	Pearson r			Comparisons with LET					
	Denominators			WOR		IND CLAU		SEN	
	WOR	IND CLAU	SEN	Z Diff.	CR	Z Diff.	CR	Z Diff.	CR
Word Level of Analysis (N = 5,181)									
LET/--	-.50								
SYL/--	-.40			.126	8.97*				
Independent Clause Level of Analysis (N = 405)									
LET/--	-.55	-.43							
SYL/--	-.45	-.42		.133	1.87	.012	.17		
WOR/--		-.45				-.094	1.33		
Sentence Level of Analysis (N = 365)									
LET/--	-.42		.46						
SYL/--	-.35		.46	.082	1.18			.000	.00
WOR/--			.39					.076	1.08
Passage Level of Analysis (N = 20)									
LET/--	-.68	-.81	-.67						
SYL/--	-.63	-.80	-.70	.088	.23	.028	.08	.057	-.14
WOR/--		-.77	-.58	.		.107	.31	.148	.44

*Significant at the .01 level

Part of Speech and Form Class Ratios

Initially this part of the study was undertaken in order to determine if the adjective to verb ratio correlated with comprehension difficulty. But one question after another arose, and the study was expanded somewhat. A ratio was found between the number of words of each part of speech and the number of words of each other part of speech. Also, a ratio was found of the number of words of each part of speech divided by the total number of all other types of words. The ratios found for each passage were then correlated with passage difficulty. The questions studied were: (1) Which of these ratios correlated with comprehension difficulty? (2) Were any high enough to be useful in the prediction of comprehension difficulty? An identical study was made using the form classes instead of the parts of speech as defined in traditional grammar. This set of correlations was of particular interest because it included the adjective to verb ratio as Boder (1940) defined it.

Form Class Ratios

Table 15 shows the correlations between the form class ratios and comprehension difficulty. The table is read in this way. The correlations involving ratios in which the numbers of nouns were in the denominator are shown in this first line. Thus the correlation for the verb to noun ratio (.13) is shown in the first line, second column.

A number of these correlations was significant. The largest of them involved the class labeled structural words. As a group the poorest seemed to be those involving the group labeled adverbs. Many of these correlations compared favorably with the best of the variables of the conventional type. Obviously many are high enough to make excellent readability predictors.

TABLE 15. CORRELATIONS BETWEEN PASSAGE DIFFICULTY AND EACH OF THE FORM CLASS RATIOS (N=20).

Denominators	Numerators of the Ratios*				
	Pearson Product Moment				
	n**	v	adj	adv	Str
n	--	13	-61	10	-66
v	-19	--	-57	07	-56
adj	55	58	--	46	37
adv	-14	-12	-34	--	-22
Str	67	67	-39	37	--
all other	49	49	-56	23	-69

*Correlations of .44 or higher were significant at the .05 level.
**Conventional part of speech names were given as an aid in interpretation of this table, but the correspondence of the form classes to parts of speech is approximate. The abbreviations used are read: form class 1=n=noun, form class 2=v=verb, form class 3=adj=adjective, form class 4=adv=adverb, and Structural words=Str.

Part of Speech Ratios

Table 16 shows the correlations obtained by using ratios calculated among the numbers of words falling into traditional part of speech categories. The highest was the pronoun to conjunction ratio. It ranked as one of the highest correlations obtained in this or any other study of readability. As a group the other ratios involving the conjunction appeared to be good predictors also. The ratios involving interjections appeared to have high correlations also, but this was probably an artifact of this particular set of data. Only two passages contained any words of this part of speech. The ratios involving adverbs had generally higher correlations in this classification scheme.

TABLE 16. CORRELATIONS BETWEEN PASSAGE DIFFICULTY AND EACH OF THE PART OF SPEECH RATIOS (N=20).

Denominators	Numerators of the Ratios*							
	Pearson Product Moment Correlations							
	n**	pn	v	adv	prep	conj	adj	intj
n	--	23	20	21	-46	-34	-36	-61
pn	-36	--	-36	-13	-44	-52	-46	62
v	-28	31	--	12	-46	-57	-48	61
adv	-31	-01	-20	--	-39	-51	-44	63
prep	54	47	51	44	--	-15	21	55
conj	56	81	73	66	22	--	30	61
adj	37	39	43	47	-11	-25	--	58
intj	53	54	53	55	44	52	48	--
all other	07	39	42	33	-42	-44	-43	60

*Correlations of .44 and higher were significant at the .05 level.

**the abbreviations used on this table are read: n=noun, pn=pronoun, v=verb, adv=adverb, prep=preposition, conj=conjunction, adj=adjective, intj=interjection.

The most interesting results can be obtained from comparing the correlations for the form class ratios with the correlations for the part of speech ratios. Although, in the tables these grammatical classifications bore similar names, they were in fact slightly different in the words that they contained. The form class categories tended to exclude many words that were included in the part of speech categories bearing similar names. These differences produced markedly different results. This strongly suggests that still better predictors remain to be found among the part of speech categories.

Other New Variables

Word Depth

The word depth measure, though it had virtually no correlation with comprehension difficulty at the word level of analysis, seemed to be a fair predictor at other levels. As will be shown in the next section, mean word depth accounted for a significant amount of variance in the multiple correlations with comprehension difficulty. This occurred at all but the sentence level of analysis.

Independent Clause Frequency

This variable failed to yield significant correlations with comprehension difficulty at any level of analysis.

Letter Redundancy

Letter redundancy yielded somewhat higher correlations with passage difficulty than independent clause frequency, but these correlations also failed to reach a significant level. However, this result cannot be interpreted as conclusive, since the passages used in this study were much shorter than is required to obtain a reliable estimate of redundancy.

Readability Prediction at Lower Levels of Analysis

Purpose

The intent of this section of the study was to find out if it was possible to predict accurately the readabilities of small language units such as words, independent clauses, and sentences. Two questions were studied. The first was what proportion of the readability variance can be predicted at each level? The second was how does the amount of variance predicted at each level compare with the amounts predicted at each of the other levels of analysis.

Method of Analysis

A stepwise multiple regression technique was used in this analysis. Using this method involved adding variables to the equation one at a time. After each variable was added, the multiple R was computed between the linguistic variables then in the equation and comprehension difficulty. Also at each step, a partial correlation was computed between each of the linguistic variables not yet entered into the equation and comprehension difficulty. The variables that were already in the equation were held constant in these partial correlations. An F ratio was also computed for each of the partial correlations. The variable that was entered to begin any step was the variable which had had the highest partial correlation on the immediately preceding step. When none of the F ratios for the partial correlations was any longer significant, the computations were stopped.

Limitations of the Method of Analysis

Since this method of analysis assumes that the relationships among the variables are linear, it was not entirely appropriate for use at the word level of analysis where the variables were shown to be curvilinearly related to comprehension difficulty. At this level of analysis the multiple R probably represents an underestimate of the amount of correlation possible using that set of variables. At the independent clause and sentence levels, where only one variable proved to be curvilinear, the multiple R was probably fairly accurate. At the passage level no criticism of this sort can be made of the analysis.

Word Level

Correlations were found among each of the pairs of variables at the word level of analysis. These correlations are shown in Table 17 along with the mean and standard deviation of each variable.

TABLE 17. CORRELATIONS AMONG THE VARIABLES DERIVED AT THE WORD LEVEL OF ANALYSIS (N = 5, 181).*

Name of Variable	1	2	3	4	5	$\overline{X}$	s
1. COM DIF		-395	-498	286	002	29.66	21.61
2. SYL			807	-487	-082	1.41	.76
3. LET				-482	-115	4.47	2.27
4. WOR FRE					071	46.88	13.17
5. WOR DEP						1.65	.76

*Correlations of .027 are significant at the .05 level and correlations of .036 are significant at the .01 level.

TABLE 18. LINEAR MULTIPLE REGRESSION ANALYSIS OF THE CORRELATIONS BETWEEN WORD DIFFICULTY AND THE LINGUISTIC VARIABLES DERIVED AT THE WORD LEVEL OF ANALYSIS (Minimum F value required for a variable to enter was 3.84.).

Table 18a. Summary of the Stepwise Multiple Regression

Step	Variable Entered	F to Enter	R	R^2	Increase in R^2	Number of Variables Included
1	LET	1708.14	.493	.248	.248	1
2	WOR DEP	21.80	.501	.251	.003	2
3	WOR FRE	19.70	.504	.254	.003	3
4	SYL	3.89	.505	.255	.001	4

Table 18b. Partial Correlations and F Values of the Linguistic Variables not in the Regression Equation at Each Step Holding Constant the Variable(s) in the Equation.

Name of Variable	Step							
	1		2		3		4	
	r	F	r	F	r	F	r	F
SYL	.01	.99	.02	1.18	.03	3.89	--	--
WOR FRE	.06	18.86	.06	19.70	--	--	--	--
WOR DEP	-.06	21.80	--	--	--	--	--	--

Table 18 shows the results of the multiple regression analysis. All four of the variables entered the regression equation. Because the number of cases was very large, only a small partial correlation was required in order to obtain a significant F. As a result word depth, whose zero order correlation was not significant, entered the equation because its partial correlation had a highly significant F.

None of the correlations increased the R by an appreciable amount once the letters variable had entered the equation. At best these correlations could account for about 25 percent of the word difficulty variance. However, it should be remembered that only a few variables were used and that these had stronger relationships than were shown by the Pearson r's used in this analysis.

Independent Clause Level

The intercorrelations among the variables derived at the independent clause level are shown in table 19 along with the means and standard deviations of these variables. As was shown above, all of these variables were linearly related to independent clause difficulty except the variable, words on the Dale List of 3,000 Familiar Words. Since this was the case, the correlations shown in this table are probably fairly accurate estimates of the strengths of these relationships. Further, the multiple regression analysis probably yielded a fairly accurate set of results.

Table 20 shows the results of the multiple regression analysis. Six variables entered the equation. The first two variables accounted for most of the variance that was predicted. At this level of analysis and using this set of variables, it was possible to predict about 44 percent of the independent clause difficulty variance.

TABLE 19. INTERCORRELATIONS AMONG INDEPENDENT CLAUSE DIFFICULTY AND THE LINGUISTIC VARIABLES DERIVED AT THE INDEPENDENT CLAUSE LEVEL OF ANALYSIS (N=405).*

Variable**	$\overline{X}$	s	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	32.54	11.98	-42	-45	-48	-43	-55	-35	30	42	44	-32	-21	-33	-29	-20	05
2	17.99	13.34		35	91	99	28	97	-20	-33	-29	77	30	91	80	27	-07
3	1.39	.26			64	29	30	16	-39	-53	-62	18	13	10	05	00	05
4	5.30	5.21				88	52	78	-29	-46	-47	68	29	71	60	18	-04
5	56.82	41.88					28	98	-18	-30	-26	76	29	92	82	28	-06
6	4.42	.70						11	-33	-46	-54	13	09	07	03	-02	09
7	12.69	8.86							-13	-22	-16	75	28	96	86	30	-08
8	47.25	4.47								59	71	-14	-07	-10	-07	-02	-01
9	.71	.17									72	-28	-20	-17	-12	-05	06
10	.85	.13										-23	-17	-11	-06	01	00
11	.37	1.51											65	68	57	14	-09
12	.29	.25												19	11	-04	-04
13	20.96	18.95													97	50	-08
14	8.27	10.88														62	-08
15	1.56	.41															-09
16	162.82	264.77															

*Correlations of .10 are significant at the .05 level.

**Names of Variables:

1. IND CLAU DIF	5. LET	9. DL 769/WOR	13. ΣWOR DEP
2. SYL	6. LET/WOR	10. DL 3000/WOR	14. ΣWOR DEP-WOR
3. SYL/WOR	7. WOR	11. PREP PHR	15. ΣWOR DEP/WOR
4. SYL-WOR	8. ΣWOR FRE/WOR	12. WOR PREP PHR	16. IND CLAU FRE

TABLE 23. LINEAR MULTIPLE REGRESSION ANALYSIS OF THE CORRELATIONS BETWEEN INDEPENDENT CLAUSE DIFFICULTY AND THE LINGUISTIC VARIABLES DERIVED AT THE INDEPENDENT CLAUSE LEVEL OF ANALYSIS (Minimum F value for a variable to be entered was 3.86.).

Table 23a. Summary of the Stepwise Multiple Regression.

Step	Variable Entered	F to Enter	R	R^2	Increase in R^2	Number of Variables Included
1	LET/WOR	177.23	.553	.306	.306	1
2	WOR	56.25	.625	.391	.085	2
3	DL 3000/WOR	13.23	.640	.410	.019	3
4	WOR DEP/WOR	12.83	.655	.429	.019	4
5	WOR PREP PHR	5.45	.660	.436	.007	5
6	SYL	4.62	.665	.442	.006	6

Table 23b. Partial Correlations of the Linguistic Variables not in the Regression Equation at Each Step, Holding Constant the Variable(s) in the Equation.

Names of Variables	Step											
	1		2		3		4		5		6	
	r	F	r	F	r	F	r	F	r	F	r	F
SYL	34	51.49	04	.00	11	.82	10	3.78	11	4.62	--	--
SYL/WOR	02	.12	02	.24	10	3.73	10	3.81	10	4.19	04	.00
SYL-WOR	20	33.50	04	.31	11	4.02	10	3.78	11	4.62	00	.00
LET	34	51.96	08	2.04	11	4.46	09	3.17	09	3.89	03	.30
LET/WOR	--	--	--	--	--	--	--	--	--	--	--	--
WOR	35	56.25	--	--	--	--	--	--	--	--	--	--
ΣWOR FRE/WOR	14	8.59	12	5.61	00	.00	00	.00	00	.01	01	.04
DL 769/WOR	23	21.48	17	12.31	08	2.52	07	2.25	07	1.71	07	2.19
DL 3000/WOR	21	18.18	18	12.23	--	--	--	--	--	--	--	--
PREP PHR	31	41.38	07	2.08	04	.79	07	1.94	01	.08	01	.01
WOR PREP PHR	19	15.19	11	4.67	09	3.24	12	5.45	--	--	--	--
ΣWOR DEP	35	55.85	05	1.11	07	2.19	08	2.67	06	1.42	07	2.22
ΣWOR DEP-WOR	33	47.65	05	1.11	07	2.19	08	2.67	06	1.42	07	2.22
ΣWOR DEP/WOR	26	28.42	17	11.58	18	12.83	--	--	--	--	--	--
IND CLAU FRE	12	5.66	09	3.33	08	2.81	07	2.16	07	1.99	07	2.20

Sentence Level

Table 21 shows the intercorrelations among the variables derived at the sentence level of analysis. An inspection of the patterns of the correlations in this table show that the sentence and independent clause levels were nearly identical. However, the correlations of many of the variables with comprehension difficulty were slightly higher at the sentence level. This may have been due to slight increases in the variances of nearly all of the variables.

Table 22 shows the results of the multiple regression analysis of these correlations. Seven of these variables entered the regression equation. It was interesting to note that, while the first variable to enter had a lower correlation, the total proportion of variance predicted was somewhat higher at this level of analysis than at the independent clause level. However, if variances are compared at the fourth and fifth steps of the analysis, it can be seen that the results were nearly identical. The maximum amount of variance predicted at the sentence level of analysis was about 46 percent of the total. This was only slightly greater than the amount predicted at the independent clause level.

Passage Level

Because of the limited capacity of the computer program used in this analysis, it was necessary to break the variables into two groups at the passage level.

Traditional and Form Class Variables

Table 23 shows the intercorrelations among the traditional and form class variables. It can be seen that the correlations at this level of

TABLE 21. INTERCORRELATIONS AMONG SENTENCE DIFFICULTY AND THE LINGUISTIC VARIABLES DERIVED AT THE SENTENCE LEVEL OF ANALYSIS (N=365).*

Variables**	$\bar{X}$	S	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	33.10	12.24	-46	-35	-51	-46	-42	-39	36	47	48	-37	-19	-34	-29	-15	06
2	20.08	15.32		30	89	99	24	97	-11	-27	-22	78	30	92	84	42	-11
3	1.38	.27			60	25	83	12	-04	-35	-33	17	17	08	04	12	06
4	5.06	5.69				36	49	76	-16	-40	-37	70	32	69	60	30	-07
5	63.38	48.69					24	98	-09	-24	-19	77	28	94	86	42	-10
6	4.39	.74						10	04	-27	-23	13	14	06	04	13	10
7	14.19	10.54							-05	-17	-10	75	26	97	91	45	-12
8	46.89	5.64								65	78	-08	-01	-03	01	17	04
9	.71	.17									75	-26	-18	-12	-08	02	07
10	.85	.14										-19	-12	-06	-01	11	04
11	1.52	1.65											69	68	60	27	-11
12	.28	.23												18	11	03	-09
13	23.41	23.06													98	57	-10
14	9.19	13.08														64	-09
15	1.52	.37															-08
16	165.63	271.22															

*Correlations of .10 are significant at the .05 level.
**Names of Variables

1. SEN DIF	5. LET	9. DL 769/WOR	13. ΣWOR DEP
2. SYL	6. LET/WOR	10. DL 3000/WOR	14. ΣWOR-DEP/WOR
3. SYL/WOR	7. WOR	11. PREP PHR	15. ΣWOR DEP/WOR
4. SYL-WOR	8. ΣWOR FRE/WOR	12. WOR PREP PHR	16. IND CLAU FRE

TABLE 25 LINEAR MULTIPLE REGRESSION ANALYSIS OF THE CORRELATIONS BETWEEN SENTENCE DIFFICULTY AND LINGUISTIC VARIABLES DERIVED AT THE SENTENCE LEVEL OF ANALYSIS (Minimum F value required for a variable to be entered was 3.85.).

Table 25a. Summary of Stepwise Multiple Regression

Step	Variable Entered	F to Enter	R	R^2	Increase in R^2	Number of Variables Included
1	SYL-WOR	128.29	.511	.261	.261	1
2	DL 3000	54.33	.598	.358	.097	2
3	LET/WOR	16.68	.621	.386	.028	3
4	SYL	31.53	.660	.436	.050	4
5	WOR	7.05	.668	.446	.010	5
6	SYL/WOR	5.27	.674	.454	.008	6
7	DL 769	5.23	.680	.462	.008	7

Table 25b. Partial Correlations of the Linguistic Variables not in the Regression Equation, at each Step Holding Constant the Variable(s) in the Equation.

Names of Variables	Step 1 r	Step 1 F	Step 2 r	Step 2 F	Step 3 r	Step 3 F	Step 4 r	Step 4 F	Step 5 r	Step 5 F	Step 6 r	Step 6 F	Step 7 r	Step 7 F
SYL	02	.16	13	6.33	28	31.53	--	--	--	--	--	--	--	--
SYL/WOR	06	1.24	01	.01	24	22.73	13	6.39	12	5.27	--	--	--	--
SYL-WOR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LET	05	.98	17	10.56	28	31.13	02	.13	02	.21	09	3.04	09	3.11
LET/WOR	22	18.13	21	16.68	--	--	--	--	--	--	--	--	--	--
WOR	01	.01	13	6.03	27	28.87	14	7.05	--	--	--	--	--	--
ΣWOR FRE/WOR	33	44.31	08	2.41	15	8.64	13	6.30	11	4.18	10	3.63	07	2.00
DL 769	34	45.90	12	5.29	11	8.52	12	4.91	11	4.64	12	5.23	--	--
DL 3000	36	54.33	--	--	--	--	--	--	--	---	--	--	--	--
PREP PHR	01	.04	05	1.07	14	6.95	05	.74	05	1.06	04	.45	02	.21
WOR PREP PHR	03	.44	04	.56	05	.75	05	.78	06	1.16	05	1.00	04	.64
ΣWOR DEP	01	.03	11	4.18	23	19.66	10	3.44	06	1.20	05	.92	05	.83
ΣWOR DEP-WOR	03	.23	09	2.63	18	12.04	09	3.19	06	1.20	05	.92	05	.83
ΣWOR DEP/WOR	01	.03	09	2.93	09	3.13	00	.01	03	.23	04	.51	03	.41
IND CLAU FRE	03	.34	03	.26	06	1.36	05	1.01	06	1.21	06	1.23	05	.93

TABLE 23. INTERCORRELATIONS AMONG PASSAGE DIFFICULTY AND THE FORM CLASS AND TRADITIONAL TYPE VARIABLES (N=20)

	Name of Variables	X̄	s	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	PAS DIF	29.66	9.06	-63	-08	-70	-68	-81	-67	-41	-72	-75	-46	-70	-72	54	68	64
2	SYL/WOR	1.42	0.16		61	28	93	57	22	65	64	50	74	66	51	-47	-87	-85
3	SYL/IND CLAU	21.71	10.23			80	57	100	76	47	93	90	54	92	89	-48	-65	-58
4	SYL/SEN	25.48	14.06				28	82	100	15	64	88	24	65	87	-27	-41	-27
5	LET/WOR	4.47	0.40					55	24	62	59	48	65	58	47	-39	-79	-80
6	LET/IND CLAU	68.20	31.28						79	44	91	91	50	89	88	-45	-61	-54
7	LET/SEN	80.43	45.13							11	60	85	19	59	84	-23	-36	-22
8	PREP PHR/WOR	0.11	0.03								73	58	95	71	55	-44	-67	-64
9	PREP PHR/IND CLAU	1.67	1.00									91	76	98	90	-52	-70	-65
10	PREP PHR/SEN	1.91	1.11										62	90	98	-43	-63	-52
11	WOR PREP PHR/WOR	0.33	0.11											79	65	-52	-72	-70
12	WOR PREP PHR/IND CLAU	5.18	3.36												91	-55	-71	-68
13	WOR PREP PHR/SEN	5.93	3.75													-45	-63	-53
14	ΣWOR FRE/WOR	46.88	2.35														63	68
15	DL 769	0.69	0.10															89
16	DL 3000	0.84	0.09															
17	WOR/SEN	17.92	10.44															
18	WOR/IND CLAU	15.04	6.38															
19	ΣWOR DEP/WOR	1.65	0.23															
20	ΣWOR DEP/SEN	31.45	24.85															
21	IND CLAU FRE/IND CLAU	185.74	93.33															
22	LET RED$_4$	0.34	0.30															
23	LET RED$_{23}$	0.46	0.26															
24	Noun/all other, 1/A	0.31	0.04															
25	Verb/noun, 2/1	0.47	0.11															
26	Adjective/noun, 3/1	0.31	0.12															
27	Adverb/noun, 4/1	0.11	0.08															
28	Structural/noun, 5/1	1.35	0.24															
29	Noun/verb, 1/2	2.25	0.68															
30	Verb/all other, 2/A	0.14	0.03															
31	Adjective/verb, 3/2	0.71	0.35															
32	Adverb/verb, 4/2	0.23	0.15															
33	Structural/verb, 5/2	3.00	0.90															
34	Noun/adjective, 1/3	3.82	2.15															
35	Verb/adjective, 2/3	1.80	0.99															
36	Adjective/all other, 3/A	0.09	0.03															
37	Adverb/adjective, 4/3	0.43	0.39															
38	Structural/adjective, 5/3	4.87	1.87															
39	Noun/adverb, 1/4	18.80	18.78															
40	Verb/adverb, 2/4	8.01	7.59															
41	Adjective/adverb, 3/4	5.96	6.46															
42	Adverb/all other, 4/A	0.04	0.02															
43	Structural/adverb, 5/4	25.52	28.35															
44	Noun/structural, 1/5	0.77	0.17															
45	Verb/structural, 2/5	0.36	0.09															
46	Adjective/structural, 3/5	0.23	0.07															
47	Adverb/structural, 4/5	0.09	0.07															
48	Structural/all other, 5/A	0.41	0.04															

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
-58	-77	-55	-50	13	35	-38	49	13	-61	10	-66	-19	49	-57	07	-56	55	58	-56	46	37	-14	-12	-34	23	-22	67	67	-39	37	-69
08	44	-08	-03	-07	-24	13	-08	-55	48	-53	25	58	-72	73	-41	72	-52	-68	60	-59	-48	34	25	57	-55	38	-33	-73	47	-58	51
67	98	48	57	05	-36	24	-33	-29	50	-09	51	37	-59	61	00	65	-49	-57	48	-38	-39	16	10	34	-18	24	-51	-66	32	-28	59
97	86	81	94	14	-34	23	-48	02	50	19	58	13	-35	44	15	43	-49	-48	42	-22	-37	00	-04	16	05	08	-55	-46	29	-06	48
09	41	-07	-01	03	-27	11	-07	-46	38	-47	23	49	-61	59	-37	61	-40	-54	48	-57	-33	30	22	43	-52	31	-33	-65	36	-56	49
70	99	51	61	06	-37	24	-35	-24	47	-05	52	32	-54	56	04	61	-47	-54	45	-36	-36	13	08	29	-14	20	-52	-63	29	-24	58
99	84	83	96	15	-34	22	-49	08	47	23	57	07	-29	38	18	37	-46	-43	37	-19	-34	-03	-06	11	09	04	-54	-41	25	-03	45
-01	35	-16	-09	21	-17	-09	14	-70	15	-57	16	63	-74	53	-41	74	-11	-34	26	-51	-03	56	46	57	-58	55	-22	-76	09	-61	58
48	87	32	39	14	-32	12	-17	-50	39	-24	41	53	-72	64	-09	78	-37	-52	42	-42	-28	34	24	45	-30	39	-42	-76	24	-37	62
78	90	60	71	22	-35	14	-31	-33	46	-07	51	41	-63	61	00	70	-43	-53	45	-37	-32	25	17	37	-18	31	-50	-70	27	-27	61
07	41	-07	00	19	-21	02	10	-78	28	-54	20	74	-87	68	-36	86	-21	-46	38	-52	-15	57	45	65	-55	59	-26	-85	21	-59	60
49	85	33	40	15	-32	17	-16	-56	44	-24	40	60	-79	72	-08	84	-39	-56	47	-42	-32	36	25	50	-30	41	-41	-80	30	-36	61
77	88	61	71	22	-34	18	-29	-38	50	-07	50	48	-69	67	01	75	-44	-56	49	-36	-35	27	17	41	-17	33	-48	-73	32	-26	60
-17	-43	-05	-10	23	57	-29	39	16	-36	06	-58	-09	42	-33	-01	-45	36	39	-29	07	19	-31	-30	-55	07	-48	48	50	-12	11	-60
-23	-51	-12	-14	-01	23	-12	08	54	-46	40	-28	-55	70	-70	28	-71	51	67	-57	41	49	-31	-22	-58	41	-39	30	68	-43	42	-51
-08	-42	-01	01	01	28	-13	14	51	-43	38	-33	-54	71	-68	25	-73	46	60	-50	34	41	-30	-21	-57	37	-39	34	70	-35	38	-54
	77	86	99	14	-31	22	-51	17	43	32	57	-03	-19	28	24	27	-41	-36	31	-11	-29	-08	-10	04	18	-02	-51	-31	21	06	39
		59	69	04	-38	26	-40	-15	47	05	55	23	-47	49	11	54	-46	-50	41	-30	-34	08	04	23	-06	16	-53	-57	26	-17	56
			90	-03	-11	30	-48	18	41	46	49	-01	-17	29	40	24	-04	-34	-30	01	-31	-27	-30	-15	32	-22	-45	-25	23	19	27
				14	-29	19	-49	22	39	41	52	-06	-13	23	32	20	-37	-31	27	-03	-27	-15	-17	-05	27	-09	-46	-24	18	15	30
					21	-20	31	-23	-01	-28	-27	17	-07	08	-28	03	28	16	02	-18	11	38	39	27	-27	28	27	04	03	-18	-16
						12	59	-27	-30	-35	-56	24	06	-07	-33	-10	39	27	-16	-14	18	19	15	-04	-28	05	53	19	-09	-19	-34
							-47	07	45	-01	50	-06	-22	31	-03	25	-40	-36	36	-28	-26	06	06	21	-10	15	-51	-35	26	-20	41
								-57	-60	-41	-90	49	-02	-14	-27	-03	71	48	-38	04	42	28	19	-06	-24	09	88	24	-28	-09	-49
									-03	56	34	-94	82	-62	30	-75	-05	29	-25	37	11	-46	-28	-41	47	-39	-28	60	-19	41	-14
										-12	53	06	-43	76	-12	37	-83	-83	96	-48	-84	03	05	49	-22	15	-55	-46	90	-28	30
											19	-48	38	-38	95	-39	-03	17	-29	80	05	-76	-73	-71	97	-69	-09	38	-22	90	-25
												-26	-21	23	08	31	-62	-47	33	-22	-25	03	07	28	01	20	-97	-52	13	-17	80
													-84	69	-27	83	-03	-35	27	-36	-16	36	16	34	-43	30	19	-64	20	-39	19
														-86	18	-95	42	69	-55	48	41	-35	-18	-52	41	-39	27	91	-41	45	-51
															-25	82	-64	-83	87	-57	-72	23	11	56	-42	28	-29	-75	78	-44	35
																-23	-01	11	-25	81	02	-74	-75	-69	96	-68	01	26	-18	90	-27
																	-39	-62	47	-49	-31	40	23	52	-43	44	-36	-93	29	-49	65
																		94	-81	36	90	17	19	-30	08	00	67	49	-74	17	-40
																			-07	50	90	-01	06	-44	26	-15	55	68	-79	32	-43
																				-58	-89	10	08	54	-36	19	-39	-51	96	-38	23
																					32	-61	-58	-65	90	-58	36	60	-47	95	-49
																						18	20	-30	09	05	30	32	-91	09	-04
																							97	83	-76	97	-02	-38	-02	-70	41
																								82	-73	95	-05	-25	-03	-68	37
																									-73	90	-26	-53	40	-68	49
																										-70	10	47	-26	97	-39
																											-17	-44	04	-65	51
																												60	-19	30	-83
																													-29	59	-81
																														-24	-03
																															-55

TABLE 24. LINEAR MULTIPLE REGRESSION ANALYSIS OF THE CORRELATIONS BETWEEN PASSAGE DIFFICULTY AND LINGUISTIC VARIABLES DERIVED AT THE PASSAGE LEVEL OF ANALYSIS, INCLUDING THE FORM CLASS RATIOS BUT EXCLUDING THE PART OF SPEECH RATIOS (Minimum F value required for a variable to be entered was 4.38.).

Table 24a. Summary of Stepwise Multiple Regression.

Step	Variable Entered	F to Enter	R	R^2	Increase in R^2	Number of Variables Included
1	LET/IND CLAU	33.61	.807	.651	.651	1
2	n/str (1/s)	6.04	.862	.743	.092	2
3	LET/WOR	5.50	.899	.808	.065	3
4	ΣWOR DEP/WOR	7.59	.934	.872	.064	4

Table 24 b. Partial Correlations of the Linguistic Variables not in the Regression Equation of Each Step Holding Constant the Variable(s) in the Equation.

Names of Variables	1		2		3		4	
	r	F	r	F	r	F	r	F
SYL/WOR	34	2.27	36	2.45	23	.87	13	.23
SYL/IND CLAU	06	.07	04	.02	20	.63	05	.04
SYL/SEN	10	.17	03	.02	21	.67	41	2.85
LET/WOR	47	4.74	51	5.50	--	--	--	--
LET/IND CLAU	--	--	--	--	--	--	--	--
LET/SEN	10	.17	03	.02	22	.75	39	2.51
PREP PHR/WOR	12	.23	13	.28	16	.42	04	.02
PREP PHR/IND CLAU	06	.06	02	.00	14	.32	05	.04
PREP PHR/SEN	09	.14	04	.03	09	.13	19	.51
WOR PREP PHR/WOR	11	.20	12	.24	19	.57	06	.04
WOR PREP PHR/IND CLAU	07	.08	00	.00	16	.37	06	.05
WOR PREP PHR/SEN	04	.03	00	.0(	04	.02	28	1.24
ΣWOR FRE/WOR	33	2.01	20	.64	12	.23	38	2.30
DL 769/WOR	39	3.10	47	4.56	20	.62	16	.36
DL 3000/WOR	41	3.38	43	3.59	11	.19	10	.45
WOR/IND CLAU	05	.03	10	.16	23	.81	38	2.35

Table 24b. (Continued)

Names of Variables	1		2		3		4	
	r	F	r	F	r	F	r	F
WOR/SEN	26	1.20	41	3.14	25	.98	06	.04
ΣWOR DEP/WOR	27	1.32	17	.47	58	7.59	--	--
ΣWOR DEP/SEN	03	.02	10	.15	24	.95	44	3.41
IND CLAU FRE/IND CLAU	31	1.77	16	.40	19	.55	26	.99
LET RED$_4$	09	.14	16	.41	22	.78	12	.20
LET RED$_{11}$	32	1.98	11	.19	17	.42	14	.28
n/all others, 1/A	37	2.74	17	.46	07	.07	02	.00
v/n, 2/1	12	.24	17	.48	10	.16	10	.13
adj/n, 3/1	43	3.86	28	1.39	25	.97	03	.23
adv/n, 4/1	10	.18	20	.68	11	.17	14	.28
str/n, s/1	48	5.02	07	.07	27	1.12	33	1.71
n/v, 1/2	12	.25	13	.29	14	.28	28	1.21
v/all others, 2/A	11	.22	14	.30	11	.19	21	.62
adj/v, 3/2	25	1.14	29	1.44	11	.17	07	.07
[illegible]	17	.49	18	.52	[illegible]	.10	11	.18
str/v, s/2	15	.39	13	.29	10	.15	20	.57
n/adj, 1/3	32	1.95	05	.03	[illegible]	.04	23	.75
v/adj, 2/3	28	1.49	12	.23	[illegible]	.07	25	.91
adj/all others, 3/A	38	2.86	33	1.92	21	.70	08	.09
adv/adj, 4/3	31	1.74	23	.90	02	.00	03	.02
str/adj, s/3	14	.36	09	.12	00	.00	19	.50
n/adv, 1/4	06	.07	11	.19	04	.02	18	.46
v/adv, 2/4	10	.16	10	.18	01	.00	26	1.05
adj/adv, 3/4	19	.64	14	.33	03	.01	19	.50
adv/all others, 4/A	19	.65	20	.70	09	.11	11	.16
str/adv, s/4	09	.15	06	.05	08	.09	16	.36
n/str, 1/s	51	6.04	--	--	--	--	--	--
v/str, 2/s	34	2.27	17	.48	10	.15	14	.29
adj/str, 3/s	28	1.41	29	1.40	20	.60	05	.04
adv/str, 4/3	29	1.61	22	.85	06	.05	12	.19
str/all others, s/a	47	4.72	14	.32	02	.00	16	.35

analysis ran much higher than at the lower levels of analysis. This may have been a result of the increased reliability that resulted from averaging the variables across longer sequences of material.

Table 24 shows the result of the multiple regression analysis of these correlations. The size of the multiple correlation was somewhat surprising. So far as the author was able to determine it is the largest that has been reported. Certainly it is the highest correlation where the criterion of comprehension difficulty was determined empirically.

A total of 87 percent of the passage difficulty variance was accounted for by all four of the variables that entered the equation. This result may be attributable to either of two factors. First, the cloze procedure yields a much more reliable measure of comprehension difficulty than has been the case with tests used in earlier research. Second all of the variables that entered were being tried for the first time. Thus, the high correlation was probably due to both the use of a better research technique and to the use of variables that were more powerful predictors.

Part of Speech Variables

Table 25 shows the intercorrelations among the part of speech variables and their means and standard deviations. Unfortunately, the size of this set of variables was so great that these and the conventional type of variables could not be analyzed as a single set by the computer program.

Table 26 shows the results of the multiple regression analysis. Only one variable actually entered the regression equation. This was the ratio of pronouns to conjunctions. The _F_ ratio for the ratio of prepositions to conjunctions, by itself, accounted for about 65 percent of the

TABLE 25a. INTERCORRELATIONS AMONG PASSAGE DIFFICULTY AND EACH OF THE PART OF SPEECH RATIOS. (N=20)

Vari-ables	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	07	23	20	21	-46	-34	-36	61	-36	39	-36	-13	-44	-53	-47	62	-28	30	42	12	-46	-17	-48	61	-31	-01	-20	33	-39	-51	-46
2		-73	-02	-66	-19	-65	-61	13	70	-57	49	02	58	30	47	12	73	-54	-42	-32	53	-02	34	13	66	-09	23	-47	42	19	37
3			84	59	-16	58	09	09	-68	95	-75	-31	-67	-41	-68	09	-66	89	39	20	-63	-03	-60	09	-54	40	-13	43	-48	-08	-53
4				57	-12	64	15	02	-73	77	-40	-26	-71	-41	-69	02	-86	53	03	07	-79	-12	-75	02	-57	29	-03	41	-48	-12	-51
5					-39	54	31	30	-52	50	-53	49	-56	-21	-47	31	-48	53	28	84	-55	09	-32	30	-06	-41	-74	95	-80	-56	-75
6						-12	40	-63	12	-20	18	-25	31	01	25	-62	08	-18	-30	-35	40	-03	34	-63	33	25	39	-53	34	25	50
7							32	-29	-27	41	-26	08	-20	36	-24	-30	-36	34	29	21	-34	64	-26	-29	-34	19	-14	32	-31	30	-30
8								-31	-11	-13	02	25	-01	01	21	-30	-17	01	-27	27	01	08	40	-31	-08	-28	-24	16	-10	-19	20
9									-15	24	-21	30	-24	-36	-21	100	-09	19	22	37	-23	-34	-23	100	-27	-18	-09	82	-32	-30	-21
10										-75	36	32	58	84	94	-15	93	-67	-72	-22	86	50	79	-15	67	-27	10	-48	59	67	60
11											-83	-40	-26	-55	-80	24	-67	92	67	16	-29	-18	-71	24	-52	48	-07	42	-60	-13	-29
12												25	36	58	79	-21	53	-93	-35	-40	51	17	48	-21	57	-29	27	-51	53	31	60
13													26	39	37	80	31	-27	-42	36	19	34	42	20	-38	-82	-26	50	-40	-38	-30
14														82	93	-25	89	-67	-34	-27	92	67	01	-24	71	-21	17	-33	68	30	60
15															80	-27	74	-50	-38	-06	68	86	61	-26	46	-25	-08	-27	40	62	62
16																-21	03	-70	-28	-18	84	46	89	-21	59	-33	07	-46	57	41	03
17																	-09	19	21	37	-33	-23	-23	100	-28	-18	-29	32	-32	-38	-21
18																		-60	-03	-07	91	48	83	-09	61	-27	-03	-40	51	37	50
19																			36	36	-48	-10	-46	19	-34	36	-34	42	-01	-21	-36
20																				-17	-83	-43	-54	21	-39	37	18	23	-39	-16	-48
21																					-18	14	07	37	-34	-63	-28	90	-10	-62	-63
22																						62	80	-33	66	-15	10	-34	07	65	63
23																							66	-34	18	-13	-13	-03	13	30	74
24																								-03	42	-38	-13	-30	66	23	60
25																									-27	-18	-29	32	-33	-30	-31
26																										50	35	-07	95	72	86
27																											28	-21	60	36	36
28																												-24	70	66	67
29																													-03	-08	-00
30																														69	58
31																															61
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TABLE 25b. NAMES OF THE VARIABLES IN TABLE 25a, THEIR MEANS, AND STANDARD DEVIATIONS.

No.	Names of Variables	$\bar{X}$	s
1	Passage Difficulty	26.66	9.06
2	Noun/all other	.35	.03
3	Pronoun/noun	.31	.10
4	Verb/noun	.75	.04
5	Adverb/noun	.13	.14
6	Preposition/noun	.30	.11
7	Conjunction/noun	.09	.10
8	Adjective/noun	.30	.03
9	Interjection/noun	.01	.01
10	Noun/pronoun	4.62	3.48
11	Pronoun/all other	.07	.03
12	Verb/pronoun	2.79	.96
13	Adverb/pronoun	.79	.36
14	Preposition/pronoun	2.30	1.00
15	Conjunction/pronoun	1.14	.94
16	Adjective/pronoun	3.95	3.01
17	Interjection/pronoun	.01	.03
18	Noun/verb	1.30	.43
19	Pronoun/verb	.40	.12
20	Verb/all other	.18	.04
21	Adverb/verb	.30	.15
22	Preposition/verb	.36	.30
23	Conjunction/verb	.40	.03
24	Adjective/verb	.32	.17
25	Interjection/verb	.01	.02
26	Noun/adverb	6.25	3.00
27	Pronoun/adverb	1.60	1.02
28	Verb/adverb	4.20	2.21
29	Adverb/all other	.06	.03
30	Preposition/adverb	3.09	2.39
31	Conjunction/adverb	1.39	1.02
32	Adjective/adverb	5.61	3.67
33	Interjection/adverb	.01	.03
34	Noun/preposition	2.13	.88
35	Pronoun/preposition	.69	.31

TABLE 25b. (Continued)

No.	Names of Variables	$\bar{X}$	s
36	Verb/preposition	1.63	.85
37	Adverb/preposition	.33	.30
38	Preposition/all other	.13	.02
39	Conjunction/preposition	.62	.44
40	Adjective/preposition	1.86	.57
41	Interjection/preposition	.02	.07
42	Noun/conjunction	6.64	2.21
43	Pronoun/conjunction	1.30	.79
44	Verb/conjunction	3.06	1.64
45	Adverb/conjunction	1.00	.02
46	Preposition/conjunction	2.38	1.23
47	Conjunction/all other	.07	.03
48	Adjective/conjunction	6.06	2.07
49	Interjection/conjunction	.02	.11
50	Noun/adjective	1.19	.38
51	Pronoun/adjective	.27	.07
52	Verb/adjective	.80	.34
53	Adverb/adjective	.06	.12
54	Preposition/adjective	.28	.16
55	Conjunction/adjective	.22	.10
56	Adjective/all other	.23	.08
57	Interjection/adjective	.01	.02
58	Noun/interjection	5.01	13.30
59	Pronoun/interjection	1.36	4.04
60	Verb/interjection	8.03	18.30
61	Adverb/interjection	1.30	6.44
62	Preposition/interjection	1.36	7.13
63	Conjunction/interjection	.40	5.61
64	Adjective/interjection	3.36	10.63
65	Interjection/all other	.01	.01

33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 26. LINEAR MULTIPLE REGRESSION ANALYSIS OF THE CORRELATIONS BETWEEN PASSAGE DIFFICULTY AND THE PART OF SPEECH RATIOS DERIVED AT THE PASSAGE LEVEL OF ANALYSIS (Minimum _F_ ratio required for a variable to enter was 4.38.).*

Table 26a. Summary of Stepwise Multiple Regressions.

Step	Variable Entered	_F_ to Enter	R	R^2	Increase in R^2	Number of Variables Included
1	pn/conj	33.07	.805	.648	.648	1
2	prep/n	4.27	.845	.719	.071	2

Table 26b. Partial Correlations of the Linguistic Variables not in the Regression Equation, at Each Step Holding Constant the Variable(s) in the Equation.

Name of Variable	1		2	
	r	F	r	F
n/all other	19	.66	11	.21
pn/n	01	.00	04	.03
v/n	13	.31	11	.20
adv/n	00	.00	19	.58
prep/n	45	4.27	--	--
conj/n	08	.11	06	.05
adj/n	37	2.75	24	.97
intj/n	04	.03	40	2.96
n/pn	00	.00	01	.00
pn/all other	06	.07	03	.01
v/pn	08	.10	12	.23
adv/pn	09	.13	25	1.09
prep/pn	13	.27	03	.01
conj/pn	05	.04	03	.02
adj/pn	15	.38	09	.14
intj/pn	05	.03	39	2.81
n/v	03	.02	04	.02
pn/v	10	.16	15	.35
v/all other	30	1.66	22	.81
adv/v	17	.48	36	2.33
prep/v	26	1.27	09	.12
conj/v	02	.00	14	.34
adj/v	32	1.39	23	.86
intj/v	04	.03	39	2.96

Table 26a. (Continued)

Name of Variable	1		2	
	r	F	r	F
n/adv	03	.02	10	.17
pn/adv	07	.08	06	.05
v/adv	05	.04	13	.29
adv/all other	00	.00	28	1.37
prep/adv	21	.78	02	.01
conj/adv	05	.05	01	.00
adj/adv	24	1.00	04	.02
intj/adv	05	.04	38	2.63
n/prep	27	1.33	42	3.41
pn/prep	13	.27	23	.87
v/prep	26	1.23	14	.34
adv/prep	09	.15	38	2.77
prep/all other	29	1.55	11	.18
conj/prep	19	.66	06	.05
adj/prep	01	.00	36	2.46
intj/prep	03	.02	43	3.61
n/conj	03	.01	03	.02
pn/conj	--	--	--	--
v/conj	06	.06	15	.37
adv/conj	12	.26	36	2.33
prep/conj	23	.93	14	.33
conj/all other	13	.31	05	.04
adj/conj	33	2.02	12	.22
intj/conj	04	.03	40	3.07
n/adj	40	3.20	24	.98
pn/adj	16	.43	02	.01
v/adj	36	2.49	22	.83
adv/adj	15	.39	22	.80
prep/adj	05	.05	29	1.50
conj/adj	19	.64	03	.01
adj/all other	38	2.87	24	.98
intj/adj	04	.02	42	3.43
n/intj	04	.03	08	.10
pn/intj	04	.03	07	.09
v/intj	04	.03	08	.11
adv/intj	04	.03	06	.07
prep/intj	03	.02	14	.32
conj/intj	04	.03	09	.13
adj/intj	04	.02	12	.22
intj/all other	04	.03	41	3.23

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*The ratio of prepositions to nouns did not reach this criterion level, but it was entered anyway in order to gain some knowledge of how this set of variables could be expected to enter if the experiment were repeated using a larger number of passages.

passage variance.

Comparisons among the Levels of Analysis

It is possible to state that, in general, the larger the language unit being analyzed, the greater is the accuracy with which its readability is predicted. This was shown by the fact that 25, 44, 46, and 87 percents of the variances were accounted for at the word, independent clause, sentence, and passage levels respectively.

CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

Linearity of the Relationships

Word Level of Analysis

The relationships between each of the linguistic variables and comprehension difficulty were tested for linearity at the word level of analysis. All of the relationships, except that involving word depth, were found to be curvilinear. The exception in the case of word depth was due to the fact that there was no relationship at all between it and comprehension difficulty at this level of analysis.

These findings have direct implications for the methods used in readability prediction. First, they show that word length, whether measured in syllables or letters, has a high validity in predicting the difficulties of words. But they also show that these numbers should not be averaged or otherwise used in linear regressions at the word level of analysis unless they have first been transformed appropriately. At any level of analysis, failure to transform these values must necessarily result in biased means that result in some reduction in sizes of the correlations.

Second, the data showed that the practice of using lists of easy words throws away much of the information that is most valuable for the prediction of comprehension difficulty. This is because these lists tend to lump together the short, high frequency words. The data showed that differences among words in these ranges were the most effective in predicting comprehension difficulty.

Third, the use of Thorndike's frequency indices yields a relatively poor prediction of readability. But if they are used, the indices of high frequency words should be included. Differences in frequency in this range are associated with large differences in comprehension difficulty. Further, if frequency indices are used, they should be transformed before they are averaged. Here, again, a failure to transform the numbers results in biased averages; averages in which the weight given to low frequency words exceeds the actual amount of effect that these words have on comprehension difficulty.

Finally, it seems that we have overrated the amount of difficulty arising from very long words and from very low frequency words. While both length and frequency are associated with comprehension difficulty throughout their ranges, the relationship is not linear. Words longer than two syllables or of more than five letters add only slightly to comprehension difficulty. The same may be said of low frequency words. The differences that were associated with the greatest amount of difference in comprehension difficulty were those occurring among the relatively short and high frequency words.

Independent Clause Level of Analysis

The chief value of the analysis at this level was to examine the linearity of variables which could not be quantified at the word level of analysis. Nearly all of the variables were linearly related to comprehension difficulty. The lone exception was the proportion of words on the Dale List of 3000 Familiar Words, but this effect, though it was statistically significant, was not great. Its chief effect, to judge from the shape of the curve, would be to overestimate the difficulties of very easy passages; that is, passages in which more than ninety percent of the words were on this list. It appeared justified to use statistics involving the assumption of linearity with all of the other variables at this level.

Passage Level of Analysis

Like the analysis at the independent clause level, the chief purpose of this analysis was to test the variables that did not appear at lower levels. None of these variables was curvilinear. Consequently, it appears to be justified to make use of the Pearson product moment correlation when performing readability predictions at this level.

Variable Strength as a Function
of Reading Achievement

Purpose

The purpose of this analysis was to find out if different readability formulas and variables were required for predicting the difficulties of materials for subjects at different levels of reading ability. The difficulties of the language units were calculated for groups which differed in mean reading achievement scores. The language units were then stratified by thirds on the basis of their values on each of the linguistic variables and an analysis of variance and a multiple range test performed to see if the comprehension difficulties of the thirds differed significantly from each other at each of the levels of achievement.

Word Level

The variables at this level of analysis predicted readability with about uniform effectiveness throughout the full range of levels of achievement studied. It was concluded that these variables continued to contribute to comprehension difficulty as the reading achievement of the subjects increased.

Further, since the word depth variable showed a significant relationship with word difficulty in this analysis, it was concluded that word depth and word difficulty are related. However, this relationship was the weakest for any of the variables at this level.

Independent Clause Level

At the independent clause level nearly all of the variables showed a uniform strength throughout the full range of the achievement levels of the subjects. The lone exception was the independent clause frequency variable which discriminated only for readers at the lowest level of achievement. And, for the readers at that level, independent clause frequency was among the poorest discriminators.

Two facts may explain why independent clause frequency behaved in this way. First, perhaps it was a generally poor predictor because the patterns were based on Strickland's (1962) first level of analysis. The methods used at that level tended to ignore the presence or absence of many substructures of language such as prepositional phrases. As a result, much important information about sentence patterns was ignored. Using Strickland's second level of analysis would partially solve this problem; but, unfortunately, frequency values have not been reported for sentence patterns analyzed on the second level. Second, only the oral language of children was analyzed. Thus, it is likely that Strickland's sample contained an extremely restricted range of patterns. Certainly it contained far fewer patterns than children are actually able to comprehend.

These results cast serious doubts upon some of the conclusions that have been based upon the studies of these patterns. Particularly, these results challenge the use of the findings from the Strickland and Loban studies for making statements about the language patterns that children can comprehend and about the kinds of sentence patterns that should be used in books for beginning readers. The results of the present study show rather conclusively that children understand a far greater range of syntactic structures than the children in the child development studies used in their oral speech. Consequently, it seems somewhat premature to use the results of the child development studies to criticize reading textbooks and to recommend what patterns the books should contain, introduce, or avoid.

Passage Level

At the passage level most of the variables seemed to be equally accurate in predicting passage difficulty for subjects at each of the levels of achievement. The exceptions were those variables which were found to have no relationship to passage difficulty. These were the independent clause frequency and both letter redundancy variables. It was concluded that the remaining variables at this level of analysis continued to contribute to comprehension difficulty as the reading achievements of the subjects increased.

New Variables

Contrasts of Similar Variables

A number of new variables were tried out in this study. Many of them were similar to established variables. The correlation of each of the new variables with comprehension difficulty was compared to the similar correlation obtained using an analogous, established variable. The conclusions reported were based chiefly on judgement since there is presently no satisfactory method of testing the significance of differences between correlations which are themselves correlated.

Net and Total Measures

Net number of syllables is found by subtracting the numbers of words in independent clauses and sentences from the total numbers of syllables in each unit. Net word depth is found in a similar manner. Correlations resulting from the net measure were compared with those resulting from the total measures. The two sets of correlations were about equal in size.

Prepositional Phrases and Words in Prepositional Phrases

The numbers of words appearing in prepositional phrases were used to obtain variables. The sizes of the correlations of these variables with comprehension difficulty were compared with the sizes of the correlations obtained from the variables derived by simply counting the number of prepositional phrases. The differences between the correlations were neither large nor consistent. It was concluded that the two variables yield roughly identical results.

The Independent Clause and the Sentence

The question was one of whether to base variables upon the independent clause or upon the sentence. Letters, syllables, words, prepositional phrases, and words in prepositional phrases were found for both sentences and independent clauses. These were then correlated with comprehension difficulty. It was found that, when letter, syllables, or words were counted, the correlations were consistently higher when the counts were based on the independent clause. When the correlations were for words in prepositional phrases and prepositional phrases, the differences between the correlations were small. It was concluded that measures of sentence length are less valid than measures of independent clause length when used for the prediction of comprehension difficulty.

Letters Compared with Syllables and Words as Measures of Length

The lengths of words, independent clauses, and sentences were measured by counting the letters, syllables, and words within each. The question was which measures of length had the highest correlations with comprehension difficulty. For measuring the lengths of words, it was found that counts of the numbers of letters consistently yielded higher correlations than counts of the numbers of syllables. The differences between these correlations were fairly large. When measuring the lengths of independent clauses and sentences, counts of letters and syllables appeared to yield about equal correlations. Both these counts yielded higher correlations than counts of the numbers of words.

Part of Speech and Form Class Ratios

Among both the part of speech ratios and the form class ratios, many were found which had significant correlations with comprehension difficulty. The ratio of pronouns to conjunctions yielded a correlation of about .81. This is among the highest correlations reported for any variable in any study. This variable and several others were high enough to be useful in readability prediction. Further, the data indicated that still better predictors of comprehension difficulty may be found by further explorations of the part of speech ratios.

Other New Variables

Word Depth

The word depth measures yielded significant correlations with comprehension difficulty at all but the word level of analysis. These correlations were high enough to allow them to enter into the multiple regression predictions of comprehension difficulty.

Independent Clause Frequency

Independent clause frequency failed to correlate significantly with comprehension difficulty on any of the levels of analysis upon which it was tried.

Letter Redundancy

Letter redundancy failed to correlate signficnatly with comprehension difficulty at the passage level, the only level on which it was tried. This result, however, should not be taken as conclusive since the passages in this study were much shorter than is required to obtain reliable estimates of letter redundancy.

Readability Prediction at the Lower Levels of Analysis

A multiple regression analysis was performed on the variables at each level of analysis. The purpose was to find out if useful readability predictions could be made at each of the lower levels of analysis.

Predictions at Lower Levels of Analysis

It was concluded that useful readability predictions can be made at the word, independent clause, and sentence levels of analysis. The percents of the comprehension difficulty variances accounted for by the multiple regression equations were 25, 44, 46, and 87 at the word, independent clause, sentence, and passage levels, respectively. These percents corresponded to multiple correlations of .51, .67, .68, and .93, in the same order. Chall (1958) pointed out that the validities of readability formulas usually range from about .5 to about .7. If this may be taken as the criterion of usefulness, then useful readability predictions can be made at every level of analysis.

Comparison of the multiple correlations that were obtained at each of the levels shows that the larger the language unit analyzed the larger the correlation obtained. This probably resulted from two factors. First, more variables were used at the higher levels of analysis. This was because there were more available for use at these levels. Up to this time researchers have concentrated their attentions entirely upon predictions at the passage level of analysis. Future research will, no doubt, contribute greatly to the number of variables suitable for use at lower levels of analysis.

Second, the somewhat higher correlations at the higher levels of analysis may have been due to the increased reliabilities of the variables that resulted from averaging across longer segments of language.

The results at the passage level deserve special attention. The multiple correlation of .93 obtained at this level is probably the highest ever reported in the literature. This may have been caused by two factors. First, the cloze tests are definitely more reliable and probably more valid than the criterion measures used by earlier researchers. Second, the variables that produced this correlation were being tried for the first time. Thus, this large correlation was probably a result of improvements in both the basic research technique and in the linguistic variables from which the predictions were made.

The results from the analysis of the part of speech variables were also particularly worthy of note, first, because the adjective to verb ratio, though it was a fair predictor, was not by any means the best of the ratios. The highest correlation was obtained from the ratio of pronouns to conjunctions. Its correlation was .81 which ranked it as one of the best predictors yet discovered. Further, it was evident that better part of speech ratios may be devised in the future by a systematic exploration of the part of speech subclasses.

Three other important results emerged from the analysis at the passage level. First, it now appears possible to attain multiple correlations that approach 1.00 at this level of analysis. Second, it now appears possible to devise three or four readability formulas, each containing a different set of variables and each having extremely high correlations with comprehension difficulty. Third, nearly all of the analysis by which the linguistic variables were derived can be performed entirely by computers (Several of the linguistic analyses used in this study were performed entirely by the computer.).

When taken as a whole this set of conclusions forecasts a new usefulness for readability prediction. These conclusions imply the following: (1) Readability prediction need no longer be an uncertain and more or less subjective art. It can achieve great precision. (2) Readability prediction formulas need no longer be oversimplified statements of what makes language difficult to comprehend, which in effect force authors into the use of stereotyped and absurd language. (3) Since readability analysis can be carried out by machine, there is no longer any reason to use only the linguistic variables that can be easily found by the average school teacher. Rather, the formulas can require sophisticated linguistic analysis and complex mathematics. Furthermore, readability analysis can be carried out economically on large masses of instructional material, if the analysis is carried out by computers.

A New Readability Formula

It is customary for authors at the end of a research report of this kind to give readability formulas which they believe are superior to all others. In the opinion of this author there are already too many readability formulas based on too little data. Only twenty passages were used in this study. Though they were carefully selected to be representative of many types of writing and of several levels of difficulty, they can hardly be said to be representative of all instructional language.

Further, twenty passages do not yield a sufficient amount of data from which to derive reliable estimates of the parameters involved in a readability formula. At a time when funds and facilities for research were scarce such a formula may have been justified. At the present time what is indicated is further research.

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BIBLIOGRAPHY

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APPENDIX

APPENDIX A

BIBLIOGRAPHY OF PASSAGES

(Listed by subject matter area and by difficulty within each area)

Literature Passages

Rambeau, John, and Rambeau, Nancy, *Jim Forest and the Bandits*, Harr Wagner Publishing Co., San Francisco, 1959, 75pp.

Proportion of Hard Words .79 Mean Sentence Length 5.72
Dale Chall Readability 4.05

Beginning on page 1 with "There is a . . ." and ending on page 8 with " . . . said Ranger Don."

Hemingway, Ernest, *The Old Man and the Sea*, Charles Scribner's Sons, New York, 1952, 140pp.

Proportion of Hard Words 6.18 Mean Sentence Length 19.92
Dale Chall Readability 5.60

Beginning on page 69 with "The line rose . . ." and ending on page 70 with " . . . but never alone."

Kipling, Rudyard, *The Jungle Book*, Grosset and Dunlap, New York, 1950, 244pp.

Proportion of Hard Words 4.91 Mean Sentence Length 53.0
Dale Chall Readability 7.04

Beginning on page 95 with "Herding in India . . ." and ending on page 96 with " . . .to be worshipped."

Dickens, Charles, Dombey and Son, The Heritage Press, New York, 1957, 798pp.

Proportion of Hard Words 15.41 Mean Sentence Length 34.38
Dale Chall Readability 7.80

Beginning on page 157 with "Mr. Dombey's offices. . ." and ending on page 158 with " . . . of the deep."

History

Emerson, Caroline D., Pioneer Children of America, D. C. Heath and Co., Boston, 1955, 302 pp.

Proportion of Hard Words 3.13 Mean Sentence Length 7.53
Dale Chall Readability 4.50

Beginning on page 2 with "Pioneers are people . . ." and ending on page 3 with " . . .to cook on."

Schwarz, Melvin, and O'Connor, John, Exploring American History, Globe Book Co., New York, 1963, 473pp.

Proportion of Hard Words 7.87 Mean Sentence Length 13.35
Dale Chall Readability 5.54

Beginning on page 249 with "In the early . . ." and ending on page 249 with " . . .in Rhode Island."

Mackey, Margaret G., Your Country's Story, Ginn and Company, Boston, 1957, 560pp.

Proportion of Hard Words 13.10 Mean Sentence Length 19.39
Dale Chall Readability 6.67

Beginning on page 223 with "Although people in . . . they were seeking," omitting "Democracy and the emigrant," and continuing with "Several miles beyond . . ." and ending on page 224 with " . . .of the Indians."

Augspurger, Everett, and McLemore, Richard Aubrey, Our Nation's Story, Laidlaw Brothers, Illinois, 1954, 864 pp.

Proportion of Hard Words 21.08 Mean Sentence Length 25.30
Dale Chall Readability 8.68

Beginning on page 261 with "The founders of . . . will preserve them," omitting "Growth of public education," continuing with "There was not . . ." and ending on page 262 with " . . .to support schools."

Geography

Sorenson, Clarence W., *Ways of Our Land*, Silver Burdett Co., New Jersey, 1961, 272pp.

Proportion of Hard Words 1.82 Mean Sentence Length 11.00
Dale Chall Readability 4.47

Beginning on page 1 with "This is the . . .to the beach," omitting "that you can . . . in the picture," continuing with "They play in . . . watch the fishermen," omitting "You see some . . . of the page," continuing with "Many of the . . . from the sea," omitting "the people of . . . changed in Rockport," continuing with "Today some of. . . it is red," omitting "The picture shows . . . into the ocean," continuing with "A lobster trip . . . of the water," omitting "As the picture shows," continuing with "a long rope . . ." and ending on page 6 with " . . . into the ocean."

Cooper, Kenneth S., and others, *The Changing New World*, Silver Burdett Co., New Jersey, 1962, 410pp.

Proportion of Hard Words 10.12 Mean Sentence Length 15.12
Dale Chall Readability 5.90

Beginning on page 290 with "At the Southern . . ." and ending on page 291 with " . . . offices in Washington."

Pounds, Norman J.G., and Cooper, Edward L., *World Geography*, Western Publishing Co., Ohio, 1957, 632 pp.

Proportion of Hard Words 16.34 Mean Sentence Length 17.13
Dale Chall Readability 7.08

Beginning on page 398 with "The desert of . . . the dry season," omitting "The two largest . . . of South America," continuing with "Northern Chile has . . ." and ending on page 399 with " . . . of broad-leaved trees."

Chamberlain, James Franklin, and Stewart, Herold E., *Air Age Geography and Society*, J. B. Lippincott Co., Chicago, 1952, 697pp.

Proportion of Hard Words 23.74 Mean Sentence Length 25.70
Dale Chall Readability 8.66

Beginning on page 396 with "There are islands . . ." and ending on page 398 with " . . . loss of trade."

Biological Science

Ware, Kay L., and Hoffsten, Gertrude B., You Find Out, The Steck Co., Texas, 1958, 112pp.

Proportion of Hard Words .794 Mean Sentence Length 9.69
Dale Chall Readability 4.24

Beginning on page 4 with "Most plants make . . . fruits and seeds," omitting "There are three . . . on these lines," continuing with "Animals cannot make . . . plants for food," comitting "There are some . . . cannot make food," continuing with "Some animals eat . . . food from plants," omitting "Choose the right . . . animals for food," continuing with "Birds make nests . . . other animals, too," omitting "In the picture . . . animals find homes," continuing with "We wear clothes . . ." and ending on page 10 with " . . .the cotton gin."

Obourn, Ellsworth S., and others, Science in Everyday Life, D. Von Nostrand Co., Inc., New Jersey, 1958, 624pp.

Proportion of Hard Words 8.20 Mean Sentence Length 12.80
Dale Chall Readability 5.57

Beginning on page 380 with "Generally speaking, there . . . things cannot do, "omitting "Living things move," continuing with "Animals move about . . . in some way," omitting "experience 17-4 . . . the light again," continuing with "plants move in . . . force or stimulus," omitting "Living things grow," continuing with "The acorn grow," and ending on page 381 with " . . into dog flesh."

Grant, Charlotte L., and others, High School Biology, McGraw Hill Book Co., Inc., New York, 1952, 813pp.

Proportion of Hard Words 15.54 Mean Sentence Length19.31
Dale Chall Readability 7.05

Beginning on page 262 with "The small intestine . . ." and ending on page 263 with " . . . your little finger."

Morrison, Thomas F., and others, Human Physiology, Holt, Rinehart, and Winston, Inc., New York, 1959, 408pp.

Proportion of Hard Words 20.61 Mean Sentence Length 37.43
Dale Chall Readability 8.75

Beginning on page 139 with "The human ear . . . mechanism of hearing," omitting "Note as you . . . the external ear," continuing with "As the name . . ." and ending on page 140 with " . . . the tympanic membrane."

Physical Science

Ware, Kay L., and Hoffsten, Gertrude B., The World About You, The Steck Co., Texas, 1958, 112 pp.

Proportion of Hard Words 2.64 Mean Sentence Length 13.25
Dale Chall Readability 4.71

Beginning on page 60 with "We make use . . . kind of static," omitting "STAT-IK," continuing with "electricity," omitting "Electric currents," continuing with "For the electrical . . . gives off light," omitting "many light bulbs . . . passes through it," continuing with "We use a . . ." and ending on page 60 with "and toast bread."

Craig, Gerald S., and Hill, Katherine E., Adventuring in Science, Ginn and Company, Boston, 1958, 288pp.

Proportion of Hard Words 13.08 Mean Sentence Length 12.38
Dale Chall Readability 6.32

Beginning on page 121 with "Do chemical changes . . ." and ending on page 121 with " . . . chemical is formed."

Burns, Elmer E., and others, Physics A Basic Science, D. Van Nostrand Co., Inc., Toronto, 1948, 546 pp.

Proportion of Hard Words 12.75 Mean Sentence Length 22.75
Dale Chall Readability 7.86

Beginning on page 344 with "Let us examine . . ." and ending on page 345 with " . . . to the ground."

Elliott, L.Paul, and Wilcox, William F., Physics A Modern Approach, The MacMillan Co., New York, 1957, 574pp.

Proportion of Hard Words 12.45 Mean Sentence Length 21.91
Dale Chall Readability 8.34

Beginning on page 313 with "Evidence proves that . . ." and ending on page 313 with " . . . free to vibrate."

Appendix B

Typing Instructions

A. Margins

1. Each passage must be typed within an 8½ x 11 paper size. Try to center it as well as you can.

2. The left hand margin may be moved as far left as the 0 mark on the elite stencil scale.

3. The right hand margin must not go beyond the 80 mark on the elite stencil scale.

4. The top margin may be moved up or down as required to fit the passage into the space allowed.

B. Text

1. Words must not be broken at the end of a line.

2. Lines will be 1½ spaces apart.

3. Special care must be taken to preserve all punctuation in the test, especially the hyphens in hyphenated words. (See 3; a, b, c, and d below.)

C. The Blanks

1. Replace each inked out word with an underline 15 spaces long.

2. Underlined blanks may not be broken at the end of a line.

3. Space before and after an underlined blank exactly as you would for the word it replaces.

   a. If it is the first part of a hyphenated word, underline up to the hyphen and then put in the hyphen without leaving a space between the underlining and the hyphen (i.e. _______________-like).

   b. If it is the second part of a hyphenated word, leave in the hyphen and do not leave a space before starting to underline (i.e. child-_______________).

   c. Leave one space between it and the following or preceeding word (i.e. Mary had _______________ little lamb).

   d. Do not leave a space between the blank and punctuation that follows it (i.e. He grows ______________, peaches, and oranges on his ______________.)

D. Indentification spaces

1. Two 20 space lines will be placed in the lower right hand corner of each page.

2. The lower line will be 3 spaces from the bottom of the page.

3. The upper line will be 3 spaces above the lower line.

E. Test Headings

1. In the upper right hand corner of the page type the test identification numbers.

2. Type the title in capital letters and center it between the margins.

3. Leave at least two spaces between the title and the first line of the passage.

4. Type the words WRITE NEATLY beginning at the left hand margin and one line above the first line of the passage.

Appendix C

INSTRUCTIONS

At the bottom of this page is a sample of a new kind of test. During the next three weeks you will take two of these tests each day. Each of these tests was made by copying a few paragraphs from a book. Every fifth word was left out of the paragraphs, and blank spaces were put where the words were taken out.

Your job will be to guess what word was left out of each space and to write that word in that space.

It will help you in taking the test if you remember these things:

1. Write only one word in each blank.
2. Try to fill every blank. Don't be afraid to guess.
3. You may skip hard blanks and come back to them when you have finished.
4. Wrong spelling will not count against you if we can tell what word you meant.
5. Most of the blanks can be answered with ordinary words but a few will be
   numbers like .... 3,427 or $12 or 1954
   contractions like .... can't or weren't
   abbreviations like .... Mrs. or U.S.A.
   parts of hyphenated words like ... self- in the word self-made
6. Write neatly.

SAMPLE TEST

Below is a sample of one of these tests. Fill each blank with the word you think was taken out. You may check your paper when you finish it by looking at the answers which are written upside down at the bottom of the page. Write Neatly.

THE BEAVER

Indians call beavers the "little men of the woods." But the
__________ really so very little. __________ beavers grow
to be __________ or four feet long __________ weigh from 30
to __________ pounds. These "little men __________ the woods"
are busy __________ of the time. That __________ why we
sometimes say, "__________ busy as a beaver."

__________ know how to build __________ that can hold water.
__________ use their two front __________ to do some of
__________ work. Cutting down a __________ with their four
sharp-__________ teeth is easy. A __________ can cut down a
__________ four inches thick in __________ 15 minutes.

ANSWERS: 1. aren't 2. most 3. three 4. and 5. 40 6. of 7. most 8. is 9. as
10. Beavers 11. dams 12. They 13. paws 14. their 15. three 16. pointed
17. beaver 13. tree 19. about.